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AGRICULTURAL RESEARCH IN RELATION TO THE COMMUNITY[1]

It is a common reproach that agriculturists have not made the same use of science as have those engaged in the other great industries—that farming is still a rule of thumb process carried out by methods which have their origin in the dark backward and abyss of time. In some respects this is indeed true. One has only to read Cato or Columella to realize that the Italian peasant of to-day is working and living in very much the same way as his Roman forebears, and even the more highly organized farming of Great Britain or Denmark or Holland is carrying on many of the essential operations of cultivation on lines that were laid down by the first great civilizers—the Romans. It is easy in fact to trace modern agriculture to a Roman ancestry; in Britain, for example, by the transplantation from the fifteenth century onwards of the traditions and practices that persisted through the dark ages in the Low Countries.

None the less progress has taken place and scientific development is going on. Under medieval systems of agriculture the yield from England's land was of the order of six to eight bushels of wheat to the acre. . . . . Latterly we have seen the yield creeping up a little through the introduction of heavier cropping wheats—the products of scientific research. . . . .

Great are the achievements and still greater the possibilities of agricultural research, but we must recognize that there are limitations to the effect of science upon agriculture which do not hold for the other industries. In the first place, in agriculture we are dealing with a living organism and the amount of control that we have obtained over plant or animal, over that stubborn essence we call life, is far less than we can exercise over inanimate nature, over iron or cement, or even the ether or the atom . . . We see no way of growing three or four crops a year under temperate climatic conditions. The organisms we are dealing with will go through their cycle and you can not hurry them. When you start hustlin ; you find you let in secondary troubles of all sorts.

These limitations lie in the nature of things, and though on looking back we can count up the immense advances that agriculture owes to the application of knowledge we must not hope for sudden developments or revolutionary changes such as have been seen in flying or wireless telegraphy. In fact for the time being I am bound to say that agriculture is actually suffering from the rapid developments and scientific achievements that have distinguished other industries. I

[1] An address delivered by A. D. Hall before the Graduate School of the U. S. Department of Agriculture, January 26, 1925.

say this advisedly and most solemnly. Agriculture is the fundamental industry, because we must all be fed, and yet you can not point to any part of the world where agricultural wealth is being turned out and find the producers in a flourishing condition. . . . .

The only hope I can see at present for large-scale production, for organized industry on the land, lies in the advances that science can make. It is research alone that will enable the big agricultural business to compete with the excessive labor of the one-man farm, to pay wages and give conditions of life to its workmen equal to those prevailing in the urban industries. It becomes then a matter of the first import to the growth of civilization itself, not merely to agriculture, that agricultural research should be encouraged.

We may consider research from two points of view. In the first place, it is an intellectual affair carried out by the individual in response to the insatiable curiosity of the mind about its surroundings and its own existence. As such, it proceeds from an artistic impulse, it is not under control and it is not amenable to considerations of utility. Just as some men must write poems or paint or make music, as other men find themselves compelled to speculate, to become philosophers or metaphysicians, so similarly the class of men we are considering must investigate nature. . . . .

So far I have only been considering research from its intellectual side as a response to man's curiosity, but the nineteenth century proved it had also a practical side inasmuch as it led to an enormously increased control over the forces of nature. I need not sing the praises of what has been effected by steam, by electricity, by modern medicine; willynilly the results are being incorporated in our daily life. Research leads to efficiency, and efficiency is a means of making money. The modern state must cultivate research if it is to become efficient and survive in the world's competition; hence all are agreed now on the endowment of research, and since in farming there are no great business corporations agricultural research must for many years to come be maintained by the state.

If, then, research is to become of such importance to the state, it behooves us to ensure conditions for the research worker under which discoveries are likely to be produced. To do this properly we must understand the psychology of the investigator. If it is true that research, like art, grows by a process of intuition, we can no more organize it into existence than we can organize the output of poetry. Nor are we likely to obtain it by a system of prizes, of rewards, commensurate to those obtained in the great professions, in industry or commerce. What we can do is to contrive sheltered places in our community in which research workers can live. We can not guarantee results,but we may wait in faith because, as we have said, the impulse to make discoveries is fundamental in man's mind. Now the sheltered places in which the research worker can live are the universities.

One last word, the state must have research in order to obtain efficiency, but does mankind really care about efficiency? At bottom man does not, he wants to "loaf and possess his soul". Efficiency is a beautiful word, but efficiency to what end? If pursued for its own sake it may become a curse.

—*Science.*

THE CAUSE OF THE ANTHRACNOSE OF AVOCADO, MANGO, AND UPO IN THE PHILIPPINE ISLANDS[1]

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WITH THREE PLATES

The anthracnose[2] of avocado (*Persea americana* Mill.) (*Persea gratissima* Gaertn.) and mango (*Mangifera indica*. L.) in the Philippine Islands was reported by Ocfemia (1924) who mentions *Glœosporium* associated with the disease. When the work on the anthracnose of avocado and mango was well under way, Dr. Miguel Manresa of the College of Veterinary Science at Los Baños submitted specimens of fruits of upo, or white squash (*Cucurbita pepo* L.) (*Lagenaria leucantha* (Lam.) Rusby) which were variously deformed due to a *Glœosporium* infection.

The work on the anthracnose of avocado and mango was started in November, 1923. Comparative morphological and cultural studies and reciprocal cross inoculation work were conducted using the conidial, or *Glœosporium* stage of the *Glomerella* on avocado and mango. Cultures of the strains of the *Glœosporium musarum* Cke. and Mass. on banana (*Musa sapientum* L.) (1921) and abaca, or Manila hemp (*Musa textilis* Née) (1925), were included in the reciprocal cross inoculation experiments. A study of the morphological and cultural characters of the conidial, or *Glœosporium* stage of the upo, or white squash *Glomerella* and cross inoculation experiments to determine its host range was started in November, 1924. Cultures of the *Glœosporium* on camias (*Averrhoa bilimbi* L.), and pepper (*Capsicum annuum* L.)[3] were included in the comparative morphological studies and cross inoculation experiments of the conidial stage of the *Glomerella* on the upo.

The work, the results of which are reported in this paper, was conducted in the Laboratory of the Department of Plant Pathology and in the nursery and orchards of the Department of Agronomy[4] of the College of Agriculture at Los Baños, Laguna, Philippine Islands.

THE DISEASE

Distribution and importance

Rorer (1919) reports that the anthracnose of avocado and mango in Trinidad and Tobago is caused by identical organisms. This author states that anthracnose is the most serious disease of avocado and mango in Trinidad and Tobago.

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[1] Experiment Station contribution No. 305. Received for publication, June 19, 1925.

[2] The term anthracnose is used in the present paper for diseases caused by species of the form genera *Glœosporium* and *Colletotrichum*, and their *Glomerella* stage.

[3] There are two anthracnose diseases of pepper in the Philippines. One is caused by a species of *Colletotrichum* and the other by a species of *Glœosporium*. The disease referred to in this article is caused by *Glœosporium*.

[4] The writers wish to thank Professor J. E. Higgins, Head of the Department of Agronomy, and other members of the Department for materials used in this investigation.

Higgins (1911, 1913) and Higgins, Hunn, and Holt (1911) report that *Glœosporium* infects flowers, foliage, and shoots of avocado, and causes death and rotting of inarched and budded seedlings in the Hawaiian Islands. Higgins (1906) states that the blight which caused the failure of the mango crop in Hawaii in 1904 was due to a *Glœosporium*.

McMurran (1914) reports anthracnose of mango in Florida due to *Colletotrichum glœosporioides* Penz. and states that Collins found the same fungus on mango in Porto Rico, and that Cardin found it in Cuba.

Stevens (1922) states that a rusty blight of avocado leaves, young stems, blossoms, and immature fruits caused by *Glœosporium* occurs in Florida. In 1924 the anthracnose of avocado caused by *Colletotrichum glœosporioides* was said to be destructive on young fruit and succulent new growth in Florida (1925). A fruit rot of avocado due to *Glœosporium* sp. was reported as common in Porto Rico (1925).

According to Condit (1915) the anthracnose of avocado in California attributed to *Colletotrichum glœosporioides*, is doing damage. The same fungus is reported as causing anthracnose of avocado and mango in Florida and in the West Indies. In 1924 the anthracnose of mango attributed to *Colletotrichum glœosporioides* was reported to be wide-spread and destructive in Florida, attacking fruit and young twigs and causing both to drop off (1925). A severe fruit rot and canker of mango attributed to *Glœosporium* sp. is reported in Porto Rico (1925).

Popenoe (1919) states that *Colletotrichum glœosporioides* attacks avocado in Guatemala and the fungus is said to be especially serious on the mango.

Gardner (1918) reports that the anthracnose of cucurbits due to *Colletotrichum lagenarium* (Pass.) Ell. and Hals. occurs wherever cucurbits are grown in a humid climate in the United States east of the Rocky Mountains, and in Europe. This author states that the disease has caused serious losses from time to time in Italy, France, Sweden, and in various states of the United States. There is no report of the occurrence of the disease in other parts of the world.

At the College of Agriculture at Los Baños, avocado and mango are sometimes severely attacked by anthracnose. Nearly every avocado tree shows infection on leaves ranging from 10 to 20 per cent of the total number of leaves on the plants.[5] Many of the failures in budding and grafting of avocado and mango, and falling of leaves and as high as 50 per cent of young fruits in the College of Agriculture have been caused by the conidial stage of the *Glomerella*. A few avocado trees have been totally defoliated and killed by the fungus. This fungus also causes storage rots of avocado. Infection of picked fruits starts from the stem-end. Mature fruits piled up and bruised or compressed are readily infected.

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[5] Mr. Faustino Q. Otanes, Entomologist of the Plant Pests Control Division of the Bureau of Agriculture, Manila, Philippine Islands, in an interview and in personal correspondence with the senior author, stated that a certain midge, the larvæ of which mine the leaves of mango and cause spots, was reared in his laboratory at the Singalong Experiment Station. Although, perhaps, insects are capable of producing lesions and openings on mango leaves into which spores of the anthracnose fungus may gain entrance, repeated inoculation experiments have shown beyond doubt that the *Glomerella* on the mango is capable of producing the symptoms readily and independently of other organisms or mechanical injuries.

Fruits of avocado and mango bruised on the trees on windy days are infected through injury and a considerable loss may result in this manner.

The conidial stage of the *Glomerella* causes storage rots of about 10 per cent of ripe mangoes in the Philippines.

The anthracnose of upo does not do much damage, inasmuch as this crop is not usually grown extensively.

Description of the anthracnose of avocado

On leaves and twigs. The fungus produces a rusty blight on the foliage, often starting from the margin (Plate I, fig. 1, a, b, and c). From this point the leaves turn rusty brown. Infected leaves fall prematurely. Succulent young branches are attacked at any point and irregular brown to purplish colored lesions are produced on them.

Field observations and laboratory examinations showed that the mycelium of the fungus in the leaves enters the branches through the petioles. This type of infection causes die-back of twigs, sometimes resulting in total destruction of branches and in severe cases may involve the entire tree.

On blossoms. The disease attacks flowers producing reddish brown discolorations. The color turns dark brown later. Infected flowers die and fall off. The fungus infects the peduncles of the fruits causing the dropping off of young fruits. Fruit infection has been found to cause die-back of twigs due to the mycelium entering the twigs by way of the peduncles.

On fruits. On the fruit the fungus produces brown spots of varying sizes. These spots increase in size, coalesce with neighboring lesions, gradually cover the entire fruit, and become sunken. Infected fruits readily fall and are finally covered with bright colored moist masses of conidia of *Glomerella* (Plate I, fig. 2, a and b.).

Description of the anthracnose of mango

On leaves and twigs. Ocfemia (1924) reports that the disease produces numerous spots on young, succulent, purplish or brownish leaves, and twigs of mango. The spots are brown, circular on the leaves (Plate II, fig. 1, a, b, and c) and more or less oval or oblong on the twigs. If favorable weather conditions exist, young leaves infected at the tips and margins are blighted (Plate II, fig 1, b).

On flowers. Minute brown specks develop on the peduncles. These spots advance towards the flowers. The lesions increase in size and often merge together forming larger ones. Infected flowers die and fall off.

On fruits. Infected mature mango fruits have brown circular spots which merge with neighboring patches forming irregular, sunken areas several centimeters in diameter. Under favorable moisture conditions pinkish moist masses of conidia of *Glomerella* develop. As a fruit rots, conidia develop all over it.

Description of the anthracnose of upo, or white squash

On leaves and stems. The disease produces small almost circular brown specks on any part of the leaves and stems. Many of the spots coalesce and form irregular patches. In moist weather these infected leaves and stems are covered with the fungus. As soon as the diseased portions die they produce an abundance of conidia if the weather conditions are favorable. Later, these infected parts

become dry, gray, and thickly covered with minute dark bodies due to formation of perithecia (Plate I, fig. 5).

On fruits. Infected fruits first show small brownish spots with water-soaked borders. Cracking of infected portions often occurs. Infection is common on the immature fruits. The disease frequently starts either from the stem-end or style-end of the fruit. The spots coalesce, forming larger lesions, sometimes involving a greater portion of the fruit. Infected fruits are variously deformed, either twisted, coiled or constricted, and do not develop to normal size. In serious infections fruits usually turn dark brown, and either rot or dry depending upon weather conditions.

CAUSAL ORGANISM

Comparative morphology of the conidial stage of the avocado, mango, and upo Glomerella

Mycelium. The mycelium of the imperfect, or *Glœosporium* stage of the *Glomerella* of avocado, mango, and upo grows abundantly in pure culture. The hyphæ are septate and hyaline when young, but become compact and dark brown in color with age.

The cells of the mycelium of the avocado strain taken from pure cultures vary from 4.5—27.5×1.5—7.5 μ, those of the mango strain vary from 5.5—26.5 ×1.5—10.5 μ, and those of the upo *Glomerella* vary from 11.1—64.2×3.4—7.4 μ. The characteristics of the mycelium of the *Glomerella* on the avocado, mango, and upo are much alike. The size of the cells of the hyphæ varies slightly. The difference in size of cells is of minor value. It may be attributed to host relationships as well as to the surrounding conditions prevalent during the growth and development of the fungus.

Acervuli. The acervuli of the fungus on the three hosts are pustular. They are usually arranged concentrically both in artificial culture and on the host tissues. When young, the acervuli are moist and pink due to the masses of conidia, but when old they are dark colored. The dark color is due to the prominence of the walls of the acervuli which are composed of thick-walled olivaceous cells. Black and irregular sclerotia-like bodies are formed around the acervuli in cultures. The acervuli are formed sub-epidermally on the host tissues, but as soon as the spore-masses develop the epidermis is ruptured, causing the acervuli to be exposed.

The diameters of the acervuli of the avocado *Glomerella* from pure culture are 100—320 μ; those of the mango, 97—298 μ; and those of the upo, 152.0—379 μ. From the figures it will be noted that the acervuli of the upo *Glomerella* are slightly larger than those of the avocado and mango strains.

In a few cases setæ were noted in the acervuli of the mango and avocado strains of *Glomerella*. The *Glomerella* of the upo produced an abundance of setose acervuli on potato-dextrose agar after 11 days. The presence of setæ had been used as a criterion for the separation of *Colletotrichum* from *Glœosporium*. During the present investigation, however, it was noted that acervuli of the imperfect, or *Glœosporium* stage of the *Glomerella* on avocado, mango, and upo sometimes have setæ like those of *Colletotrichum*. Many investigators no longer consider the presence or absence of setæ as an important character in taxonomic studies of these two form genera.

Conidiophores. The conidiophores of the avocado, mango, (Plate III, fig. 2 and 3) and upo *Glomerella* are erect, hyaline, and filiform. They are numerous, usually crowded, and simple. Each conidiophore bears a conidium at its apex. The lengths of the conidiophores of the avocado, mango, and upo *Glomerella* taken from pure culture are 10.5—19.5 μ, 12.5—20.5 μ, and 8.8—23.7 μ, respectively. As the figures show, the conidiophores of the upo *Glomerella* are slightly longer than those produced by the avocado and mango fungus.

Conidia. The avocado, mango, and upo *Glomerella* produce thin-walled conidia with granular contents. They are hyaline, ellipsoid to elongate, continuous, rounded at the ends (Plate III, fig. 1, 4, and 5) and easily detached from the conidiophores. Conidia from pure culture are slightly larger than those taken from lesions produced in the field owing perhaps to the more uniform conditions existing in culture tubes.

The conidia of the avocado *Glomerella* produced in the field vary from 12.5—19.5×3.5—5.5 μ. From pure culture, they vary from 13.0—21.5×3.5—6.5 μ. The conidia of the mango *Glomerella* from field materials vary from 12.5—20.5×3.5—6.5 μ and from pure culture they are 13.5—21.5×3.5—6.5 μ. The conidia of the upo organism from field materials are 12.2—17.2×3.4—5.1 μ. The figures show but slight differences of size of the conidia of the avocado, mango, and upo *Glomerella.*

Germination of conidia. When conidia of the avocado, mango, and upo *Glomerella* germinate, they produce one germ tube at or near the end; or two germ tubes, one from each end. In a drop of water, conidia sometimes produce a small, hyaline, conidium-like body (Plate III, fig. 8) at the end of a short germ tube in germination. Each conidium produces from one to three germ tubes. In germination, conidia usually produce a septum at the center perpendicular to their long axis. At the distal end of the germ tube a black chylamydospore-like structure may be produced 24 hours after germination (Plate III, fig. 6, 7, and 8). Halsted (1893) states that the chlamydospore-like structures are for protective purposes. Hasselbring (1906) discusses the views of different investigators regarding the structure and function of these chlamydospore-like bodies. This author and others believe that they are produced when the germ tube comes in contact with a hard surface or when the available nourishment in the medium is not sufficient. Toro (1922) calls these structures appresoria. The writers' observations agree with those of Hasselbring.

Comparative morphology of the aseogenous stage

In July, 1924, perithecia were found on fallen, dead infected leaves of avocado (Plate I, fig. 3 and 4). Subsequently, infected mango leaves which were exposed out-doors for about four months (Plate II, fig. 2 and 3) produced perithecial bodies. Experiments to induce the fungus to produce the perfect stage in culture following a method similar to that described by Matz (1916) were conducted. In these experiments slits were made in the healthy stems of avocado and mango which had been sterilized with 1:1000 mercuric chloride solution and washed with sterile water. Conidia and bits of hyphæ of the mango and of the avocado *Glomerella* taken from pure cultures were introduced into the wounds. The stems were then wrapped with paraffined paper and placed in damp chambers. After three months, examinations of the inoculated avocado

and mango stems showed an abundance of perithecia. The perithecia of the avocado *Glomerella* were more abundant than the perithecia of the mango fungus. In addition to this method, plate cultures and potato-dextrose-agar-slant cultures of the avocado and mango strains of *Glomerella* were covered with melted paraffin. The potato-dextrose-agar-slant cultures of the avocado strain did not produce perithecia, but the plate cultures produced the ascogenous stage.

Infected upo stems and leaves readily develop the perfect stage in the field (Plate I, fig. 5). The perithecia produced by the avocado and mango *Glomerella* are elongate or pear-shaped, dark-brown, membranous, shortly rostrate 200—350 ×125—250 μ, and more or less hairy (Plate I, fig. 4, and Plate II, fig. 3). The perithecia of the upo *Glomerella* are smaller, being 87.9—268.0×84.0—138.0 μ. The asci of the *Glomerella* on the three plants are generally clavate with narrow basal ends (Plate III, fig. 9a, 10a, and 11a). Each ascus contains eight hyaline, elliptic, and slightly curved ascospores (Plate III, fig. 9 a, b, and e; 10 a, b, and e; 11 a, b and d). Sometimes the ascospores are arranged in a series without a clear outline of the ascus wall (Plate III, fig. 9b, 10b, and 11b). The asci of the avocado and mango *Glomerella* vary from 48—60×12—14 μ, and those of the upo are 33.8—64.2×8.5—13.5 μ. The ascospores of the avocado and mango strains are 12.5—19.5×4.5—5.0 μ, and those of the upo *Glomerella* are 10.1—15.9× 4.4×5.4 μ. The color, shape, and the size of the fruiting structures of the ascogenous stage of the *Glomerella* on avocado and mango fit remarkably close those of *Glomerella cingulata*. Those of the upo, in turn, are similar to those of avocado and mango fungus.

Sections of perithecia showed sterile filaments simulating paraphyses (Plate III, fig. 9c and 10c). The position of these sterile fungus threads could not be ascertained in the sections prepared. The paraphyses-like filaments are longer than the asci, thin-walled, granular and sometimes branched (Plate III, fig 9c and 10c). Shear and Wood (1913) state that paraphyses are not frequently found or reported in *Glomerella* and they consider that these are not of much taxonomic value. Edgerton (1908) states that when Spaulding and Von Schrenk described the genus *Glomerella* they did not mention paraphyses. Sheldon (1906) reports paraphyses in young perithecia of certain forms of *Glomerella*. Shear (1907a, 1907b) found paraphyses-like filaments in the perithecia of *Glomerella cingulata*, *G. gossypii* Edge., and *G. lindemuthianum* Shear n. comb. He believes, however, that they are on the outer portion of the mass of asci, next to the perithecial wall.

Edgerton (1908) could not ascertain the position of the paraphyses-like structures from stained preparations.

During the course of the present investigation single-spore cultures from asci and ascospores of the *Glomerella* on avocado and mango were made on corn meal agar in petri dishes. Acervuli, identical with those produced by the imperfect stage, developed. No attempt was made to complete the life cycle of the organism by inducing the fungus to produce the *Glomerella* stage after the production of the conidial stage from single-ascus cultures.

Comparative cultural studies of the Glomerella of avocado, mango, and upo

A study of the growth of the *Glomerella* on avocado and mango in the Philippines was made, using common media and sterilized plant tissues. Sterilized

unpolished hulled rice was included; this was prepared by putting approximately the same amounts of the rice grains in test tubes and covering them with water about three centimeters deep. The tubes were plugged and sterilized in the autoclave at 15-pounds' pressure for 20 minutes.

The sterilized plant tissues were prepared by making five-centimeter cuttings of the materials used. Moist absorbent cotton was put at the bottom of the test tubes before the cuttings were introduced. The test tubes were plugged and autoclaved for 20 minutes at 15-pounds' pressure.

The following is a summary of the results obtained in the experiments to find out the relation of various media and substrata to the growth and production of conidia of the *Glomerella* on avocado, mango, and upo.

Water agar. The avocado and mango *Glomerella* produced slow and poor growth on water agar. They produced only little mycelium. Masses of conidia appeared 12 days after the transfers were made. The upo *Glomerella* was not grown on this agar.

Corn meal agar. This medium was prepared by following Shear and Wood's (1913) method of preparation. The growth of the avocado, mango, and upo *Glomerella* on corn meal agar was slow. The mycelium was scanty, but an abundance of pinkish masses of conidia was produced on the sides on the upper portions of the slants. The avocado strain developed setose acervuli, but the mango strain did not. Perithecia-like bodies were noted occasionally in cultures of the avocado strain on this medium, but no asci were found in them.

Potato-dextrose agar. The *Glomerella* of the three host plants produced very good growths on potato-dextrose agar. Abundant mycelium covered the entire surface of the slant in four to six days. Pinkish masses of conidia were produced abundantly in eight to eleven days. After eleven days the upo *Glomerella* produced setose acervuli on this agar.

Potato cylinder. Potato cylinder was a good medium for the avocado and mango *Glomerella*. The upo fungus was not grown on this medium. Five days after the transfer the avocado and mango *Glomerella* began to produce conidia.

Sterilized unpolished rice. The avocado and mango strains produced very good growth on sterilized unpolished rice. The upo *Glomerella* was not grown on this medium. The mycelium of the avocado and mango *Glomerella* grew in abundance and conidia began to appear after five days. The conidial masses of the avocado strain seemed to be lighter in color than those of the mango strain.

Banana fruit cylinder. Banana fruit cylinder was a good medium for the *Glomerella* on the three hosts. Luxuriant mycelial growth was produced and conidia appeared on the fifth day. The masses of conidia were pinkish and moist. In old cultures they became dry and gray. The masses of conidia were embedded in black crusts or stromatic bodies composed of the brown to olivaceous, thick-walled cells.

Corn meal. Plain corn meal was one of the best media for the growth of the three cultures; it compared favorably with potato-dextrose agar. Abundant mycelium covered the medium in a short time and the cultures produced numerous conidia.

Oatmeal agar. The three cultures of *Glomerella* produced good growth on oatmeal agar. After five days the mycelium turned dirty white. Numerous pinkish masses of conidia were produced.

Sterilized avocado stems. The three cultures produced abundant mycelium on sterilized avocado stems. Conidia were abundant in all cases. The mango strain developed perithecia-like bodies, but no asci were produced in them.

Sterilized mango stems. The three cultures of *Glomerella* developed masses of conidia abundantly. There were some perithecia-like bodies in the mango strain, but no asci could be found in any of these bodies.

Sterilized tomato. The three cultures produced little growth on sterilized tomato (*Lycopersicum esculentum* Mill.) stems and fruits. The mycelium was comparatively scanty. Sporulation began comparatively late.

Sterilized eggplant. The three cultures produced good growth on sterilized eggplant (*Solanum melongena* L.) stems and fruits, although the mycelium in both cases was scanty. Sporulation was plentiful. Perithecia-like bodies were produced by the avocado strain, but no asci were produced in the ascocarps.

Sterilized cowpea. Cultures of the three *Glomerellas* exhibited good growth on sterilized cowpea (*Vigna catjang* Walp.) pods and stems. Abundant and luxuriant mycelium produced large quantities of conidia.

Sterilized sword bean. The *Glomerella* of the avocado, mango and upo grew well on sterilized sword bean pods and stems (*Canavalia gladiata* L.). A vigorous growth of mycelium was produced with an abundance of conidia. The avocado strain produced perithecia-like bodies, but no asci were found in them.

Sterilized pepper. The avocado, mango, and upo *Glomerella* did not grow vigorously on stems and fruits of pepper. Both the avocado and mango strains developed a fairly good amount of conidia. The avocado and mango strains produced setose acervuli.

Sterilized banana petioles. As on sterilized pepper the cultures on banana petioles did not produce abundant mycelium. The mycelium was submerged, but it produced numerous conidia.

The behavior of the three cultures on steamed abaca petioles was similar to that on steamed banana petioles. Setose acervuli were produced by the avocado strain on abaca petioles.

Sterilized citrus stems. Sterilized citrus stems were very good substrata for the three cultures. There was an abundant production of mycelium and conidia. The mango strain produced setose acervuli. Perithecia-like bodies were produced by the mango strain, but they did not have asci in them.

Sterilized papaya petioles. The three cultures grew luxuriantly on sterilized papaya (*Carica papaya* L.) petiole. The thick mycelium produced numerous conidia. The avocado strain produced perithecia-like bodies, but no asci were observed in them.

Lima bean agar. The avocado, mango, and upo *Glomerella* exhibited good growth on Lima bean agar. Abundant and luxuriant mycelium produced large quantities of conidia.

The result of the cultural work shows that the three cultures of the imperfect stage of the *Glomerella* on avocado, mango, and upo do not produce exactly the same amount of growth, or react in the same manner on all media and substrata. Of the media used, potato-dextrose agar, plain corn meal, steamed unpolished rice, and Lima bean agar were best suited for the cultivation of the three cultures. Oatmeal and corn meal agars were next best, while water agar was the poorest.

Of the sterilized plant tissues used, sword bean, cowpea, citrus, and papaya were best. These were followed by eggplant, mango, avocado, banana, and abaca. The poorest substrata were steamed tomato and pepper.

On all culture media and substrata used in the present experiments of the conidial stages of the *Glomerella* on avocado, mango, and upo a white cottony, circular growth was produced. As the growth became old it turned brownish with black masses of hyphæ. Microscopic examination of the mycelium of the three cultures from all media and substrata showed that the filaments are of two kinds; one broad with close cross walls, and another narrow with fewer septa. Young hyphæ are hyaline or sub-hyaline, while old ones are more or less brown or olivaceous. The stromatic masses produced in cultures are made up of these olivaceous cells.

Acervuli began to form in cultures in five to twelve days after transfer. It was noted on all media and substrata that when acervuli are young and fresh the conidial-masses are pinkish. When they become older they turn brownish. These brownish masses of conidia are embedded in black stromatic masses. Examination of these black structures showed that they function as walls around the acervuli. The stroma-like bodies are composed of intertwined, old, and brown or olivaceous hyphæ.

The masses of conidia exhibited a color ranging from light to bright pink. The spore masses of the avocado *Glomerella* were slightly lighter colored. Microscopic examination of individual conidia of the avocado and mango *Glomerella* showed that they are hyaline with numerous small granules. The conidia produced on all media and substrata did not vary much in size. The shape was generally oblong with rounded ends. The media on which the three cultures produced an abundance of conidia were potato-dextrose agar, corn meal agar, oatmeal agar, plain corn meal, and steamed unpolished rice. Of the substrata used, sword bean, cowpea, citrus, and papaya produced an abundance of conidia.

Occasionally the three cultures produced setose acervuli. The avocado strain produced setæ in some of the acervuli on corn meal agar, sterilized abaca petioles, and pepper stems. The mango strain produced setæ on sterilized citrus and on pepper stems. The upo *Glomerella* produced setose acervuli on potato-dextrose agar. The formation of setæ in the acervuli of the three cultures did not occur often. Generally, only one to two setæ were present in an acervulus.

The avocado and mango strains of *Glomerella* showed a tendency to produce perithecia-like bodies of the same general type on some media and substrata. There were differences in the frequency of occurrence and in the quantity in which perithecia-like structures were produced. The avocado strain showed sterile perithecia-like structures on corn meal agar, sterilized eggplant stem, sword bean pods, and papaya petioles. On sword bean and on corn meal agar very many of these sterile structures were produced. The mango strain produced perithecia-like bodies on sterilized mango stem, citrus stem, and avocado stem. They were, however, scanty and sterile. The avocado strain produced more numerous perithecia-like structures than the mango strain. All these structures produced by both strains varied more or less in shape, ranging from globose to pear-shaped. The upo *Glomerella* had not yet been obtained in pure culture when this portion of the comparative cultural study was made.

Pathogenicity

Inoculation and cross inoculation experiments in the Philippines. Rolfs (1904), Bessey (Galloway 1907), Shear and Wood (1913), and Butler (1918) report results of cross inoculations with various species of *Glomerella* or their conidial forms.

Repeated inoculations of mango, avocado, and upo with the respective cultures of the conidial stages of their *Glomerella* parasites gave identical results. The writers found that the *Glomerella* of the avocado is responsible for the anthracnose of avocado, that of the mango causes the anthracnose of mango, and that of the upo causes the anthracnose of the upo. Sufficient control plants were used in all artificial inoculation experiments and these remained healthy until the end of the experiments. On their respective hosts the three cultures of *Glomerella* produced the characteristic symptoms which are obtained under field conditions. Moreover, they developed perithecia on dead infected leaves and stems after the death of inoculated parts.

Reciprocal cross-inoculation experiments using the avocado, mango, and upo cultures of the organism were conducted repeatedly. Leaves, twigs, and fruits of mango developed characteristic anthracnose symptoms when inoculated with the fungus from the avocado; and avocado leaves, twigs, and fruits developed symptoms of the disease when the organism from mango was applied on them, and upo was readily infected by the avocado and mango *Glomerella.*

The mango and avocado strains of *Glomerella* also infected twigs and leaves of citrus (*Citrus nobilis, C. limonum,* and *C. decumana*). *Colletotrichum glœosporioides,* isolated from wither tip of citrus, infected mango and avocado as readily as the conidial stages of their respective *Glomerella* parasites did. The results showed that the mango fungus readily attacks avocado and citrus; the avocado culture produces lesions on the mango and citrus; *Colletotrichum glœosporioides* on citrus infects avocado and citrus; the avocado culture produces lesions on the mango and citrus; *Colletotrichum glœosporioides* on citrus infects mango and avocado; and the upo *Glomerella* attacks avocado and mango.

Production of storage rots of fruits. Fruits of abaca, avocado, banana, mango, citrus (*Citrus limonum*), papaya, guava (*Psidium guajava* L.),[6] guanabanos (*Anona muricata* L.), ates (*Anona squamosa* L.), tomato,[7] eggplant, and pepper were inoculated to find whether or not the *Glomerella* cultures from avocado, mango, and upo are capable of producing storage rots. After inoculation these fruits were kept in moist chambers alongside their checks.

The inoculated fruits showed a slight variation in the date of infection. The incubation period of the fungus was from five to seven days. Each of the three cultures produced soft rots on the fruits. Fruits of banana, avocado, mango, papaya, eggplant, and guava were readily infected. Ates, guanabanos, and pepper were covered with the fungus mycelium in a short time. Citrus and tomatoes were not as readily infected as the others.

[6] Toro (1922) reports having inoculated guava with *Glœosporium musarum.*

[7] Toro (1922) reports having inoculated tomato with *Glœosporium musarum.*

The results obtained in inoculation and cross-inoculation experiments may be summarized as follows:

1. The culture of the conidial stage of the *Glomerella* from avocado is capable of infecting mango, banana, abaca, upo, citrus, pepper, papaya, camias, eggplant, guava, ates, guanabano, and tomato.

2. The *Glomerella* from mango is capable of infecting avocado, banana, abaca, upo, citrus, pepper, papaya, camias, eggplant, guava, ates, guanabano, and tomato.

3. *Glœosporium musarum* Cke. and Mass. on banana is capable of infecting abaca, avocado, mango, citrus, upo, pepper, papaya, camias, eggplant, guava, ates, guanabano, and tomato.

4. The strain of *Glœosporium musarum* on abaca is capable of infecting banana, mango, avocado, citrus, upo, pepper, papaya, camias, eggplant, guava, ates, guanabano, and tomato.

5. *Colletotrichum glœosporioides* Penz. is capable of infecting avocado and mango.

6. The *Glœosporium* stage of the upo *Glomerella* is capable of infecting avocado, mango, pepper, and tomato.

7. The camias *Glœosporium* is capable of infecting avocado, mango, and pepper.

8. The pepper *Glœosporium* is capable of infecting mango, avocado, camias, and upo.

Taxonomy

In morphological characters, behavior in culture on different media and sterilized plant tissues, and ability to infect plants the *Glomerella* on avocado and mango in the Philippines show remarkable similarity. In comparative morphological studies of the conidial and ascogenous stages the writers noted but minor differences of no taxonomic significance. Certain minor variations in morphological characters and production of conidia were noted in the *Glomerella* on avocado and mango. The variations, however, were in the same degree as reported for *Glomerella cingulata* (Stonem.) S. and v. S. by Shear and Wood (1913). The same observations were noted for the *Glomerella* on the upo.

Different investigators report different figures for size of conidia, perithecia, asci, and ascospores of *Glomerella cingulata*. The writers believe that host, climatic conditions, prevailing weather during development and sporulation of the fungus, and the number of fructifications and spores measured are partly responsible for the variations of figures reported by different workers.

In experiments to determine the relation of the avocado *Glomerella* to avocado, the mango strain to mango, the upo fungus to upo, and reciprocal cross-inoculation work the writers noted that the three cultures are very closely related to one another. Shear and Wood (1913) list *Glœosporium lagenarium* (Pass.) Sacc. and Roum. as a conidial form of *Glomerella*. These authors obtained sterile perithecia in cultures and produced successful cross-inoculations of squash with *Glomerella cingulata* from *Vitis labrusca*. They are not certain, however, that the fungus on the squash and that on the grape are the same. In the Philippines the upo organism readily infects avocado, mango, and other plants susceptible to the avocado and mango *Glomerella*. The avocado and mango cultures of

Glomerella also readily infect the upo. Moreover, the morphological characters and behavior in culture on various media and sterilized plant tissues of the upo fungus are very much the same as those of the avocado and mango *Glomerella*.

On account of the remarkable similarity of the characters of the conidial and ascogenous stages of the Philippine *Glomerella* on avocado and mango to those of *Glomerella cingulata* on avocado and mango in other tropical and subtropical countries, the writers conclude that the fungus on the avocado is identical with the organism on the mango and that these two are in turn identical with *G. cingulata*. The upo anthracnose fungus is very closely related to *Glomerella cingulata* which attacks avocado and mango.

The knowledge of the relationship of the avocado and mango *Glomerella cingulata* and the fungus of the upo in the Philippines is important in connection with the control of the disease. The strain on one host is sometimes of little economic importance, but when transferred to other hosts produces serious damage. Although no definite work has been done along this line, evidences in reciprocal cross-inoculations have been noted which seem to support this statement.

LIFE HISTORY OF GLOMERELLA CINGULATA IN RELATION TO THE PRODUCTION OF DISEASE

Production of spores

Conidia. As soon as the infected portions of avocado, mango, and upo begin to die an abundance of pink moist masses of conidia are formed on the lesions. During wet weather, infections on leaves and stems progress rapidly, causing death of the greater portions of these organs and formation of conidial masses all over them.

Ascospores. After the production of conidia, the dead infected leaves, stems, and fruits which are exposed to sunshine and rain produce the perithecial stage. The ascospores are borne in asci which are enclosed in globose or flask-shaped perithecia.

Sources of inoculum in the field

Infected fruits of avocado, mango, and upo which drop on the ground and mummify, and dry infected leaves and branches which drop off or persist on the plants are sources of inoculum for primary infection in nature on account of the conidia and ascospores produced on them. During the rainy season as soon as infected leaves, stems, and fruits begin to die, myriads of conidia are produced and these are distributed causing both primary and secondary infections. The conidia of *Glomerella cingulata* on the avocado and mango and the *Glomerella* on the upo are the most common and conspicuous spore-form present on diseased tissues.

Method of spore dissemination

Higgins (1913) reports that wind helps in the dissemination of spores of *Glœosporium* in the field. According to Edgerton (1908) conidia of *Glœosporium nervisequum* can not be blown away by the wind because they are held firmly by a mucilagenous substance. He believes that spore dissemination is caused by rain. Clinton (1902) states that the conidia of *Glœosporium fructigenum* are disseminated by *Drosophila*.

The writers studied spore dissemination both in the field and in the laboratory. Although the results were inconclusive, evidence showed that a few conidia of the avocado or mango *Glomerella cingulata* or the fungus of the upo may be disseminated by wind and that some are splashed by rain.

Various undetermined insects found on avocado and mango have been collected and used in spore-dissemination experiments. The results showed that they are responsible for the transfer of some of the spores to healthy tissues causing part of field infections.

It has been observed that when moisture is applied to perithecia they liberate the ascospores readily. Although no work has been done to determine the relation of moisture to ascospore discharge it is probable that new infections on healthy tissues arise from ascospores splashed on them by rain.

Methods of passing over the dry season in the Philippines

Infected fruits of avocado, mango, and upo become mummified and infected leaves and stems dry up. On these materials the acervuli become dry. The conidia become dirty white or gray. As the conidia disappear from tissues exposed out-doors it was not possible to determine their longevity on field materials. Infected leaves and stems of avocado, mango, and upo exposed out-doors developed perithecia in three to five months. Microscopic examinations of these materials show some viable conidia besides abundant perithecia. Under Philippine conditions some of the conidia remain viable during the dry weather for three to five months. The ascigerous stage is capable of resisting a longer period than the conidia on account of the perithecial wall. At the beginning of the wet season primary infection is brought about by conidia and ascospores. Under Philippine conditions both the conidial and ascogenous stages of the fungus remain viable from one season to another.

CONTROL MEASURES

Care of avocado and mango seedlings

Avocado and mango seedlings in cool shady places in the nursery of the Department of Agronomy became seriously infected with anthracnose. The source of infection was traced to taller infected avocado and mango seedlings.

A few seedlings of mango which were placed with the avocado seedlings were also infected with anthracnose. Observations showed that the continuous moist weather in 1924 was favorable for the development of the disease, especially on plants kept in cool shady places.

Potted seedlings of avocado and mango should not be placed in cool moist shady places, because under these conditions the disease develops very rapidly. Healthy seedlings should not be mixed with infected ones. Seedlings should be kept in clean and dry places where they can receive plenty of sunshine during the greater part of the day. Care should be taken not to keep mango seedlings with avocado seedlings in the same nursery, as both are subject to the same trouble and the strain of the fungus on one host though not serious on it may be more virulent on the other. No data for upo anthracnose were collected.

Evidence of varietal[8] *resistance to the disease*

In the nursery of the Department of Agronomy the Mexican type of avocado had 100 per cent of anthracnose infection, while Bottleneck of the West Indian type produced only two infected seedlings out of 21 plants, or 9.53 per cent; and Cyrus, also West Indian, six out of 48 seedlings, or 12.5 per cent. No observations for difference in degree of susceptibility of mango seedlings to anthracnose were made, although McMurran (1914) states that resistant varieties should be of value in the control of mango blight. According to Professor J. E. Higgins, Head of the Department of Agronomy of the College of Agriculture, mango of Cambodiana and other related varieties are less susceptible than those of the true Indian varieties. Although further work should be done before definite recommendations may be made regarding possibilities of using disease-resistant varieties of avocado for the control of anthracnose, observations seem to show that different varieties show different degrees of susceptibility to the disease. It is possible that resistant varieties may be developed and used in the control of anthracnose, both in avocado and in mango. No observations for resistance were made on different strains or varieties of upo.

Sanitation

Infected leaves, stems, and fruits of avocado, mango, and upo, should be collected and burned to prevent the fungus from producing an abundance of conidia for secondary infection during the growing season. This practice will prevent the formation of the perfect stage which is more resistant to dry weather conditions in the Philippines and forms sources of primary infection for the following rainy season.

Avocado orchards should not be opened near a mango or citrus orchard. Neither is it advisable to open an orchard of either avocado, mango or citrus near a banana or abaca plantation, fields of camias, nor intercrop orchards of these with tomato and upo. The reason for this is that the *Glœosporium musarum* Cke. and Mass. of the banana and abaca and *Colletotrichum glœosporioides* Penz. of citrus are each capable of infecting not only its own host plants but mango, avocado, and other plants as well. More important than the ability of the various species of the form genera *Colletotrichum* and *Glœosporium* to infect different plants, is the fact that although a species of the fungus is not serious on its natural host it sometimes becomes destructive on other susceptible plants.

The control of avocado and mango insects which are responsible, in part, for the transference of the spores from infected fruits and flowers should prevent the rapid spread of the disease.

Spraying

Spraying has been conducted in different avocado and mango growing countries. It seems as though in serious cases spraying with any of the standard fungicides should protect avocado, mango, and upo from severe infection.

Spraying with Bordeaux mixture, commercial lime-sulfur and self-boiled lime-sulfur was started in October, 1924. The spraying was not carried out for a period long enough that a definite statement can be made regarding the com-

[8] Identifications of types of avocado were made by Professor J. E. Higgins, of the Department of Agronomy.

parative efficiency of each of these sprays in regard to time and number of applications necessary.

SUMMARY

1. Anthracnose is a serious disease of avocado, mango, and upo in the Philippine Islands. The disease is reported on avocado in Trinidad and Tobago, the Hawaiian Islands, Florida, California, Porto Rico, West Indies and Guatemala; and on mango in Florida, Porto Rico, Cuba, Trinidad, and Tobago, the Hawaiian Islands and Guatemala. The anthracnose of upo or related species, and other cucurbits occurs in the United States east of the Rocky Mountains, in Europe, and in the Philippine Islands.

2. The disease of avocado and mango is sometimes as serious in the Philippines as in other avocado- and mango-growing countries. The anthracnose of cucurbits is reported to cause damage in the United States and in certain places in Europe. It seems, however, that the damage caused by the disease varies in different regions owing, perhaps, to differences in climatic conditions. In the Philippines, anthracnose may infect 10 to 20 per cent of the leaves of avocado, and occasionally it may involve the primary branches or even the entire tree. It may cause destruction of as high as 50 per cent of the immature fruits of avocado and mango. The disease causes some of the failures in grafting and budding of avocado and mango. On the mango the disease causes considerable damage to the fruits after windy days, and 10 per cent of picked fruits may suffer from storage rots.

3. On the avocado and mango the disease may appear as small or large, circular to irregular, brownish to purplish spots on leaves, twigs, and fruits, and discoloration of the flowers. Leaves, stems, and fruits of upo may be infected.

4. The fungus grows readily on ordinary media and on sterilized plant tissues producing abundant mycelium, conidia, and black sclerotia-like bodies. The acervuli produced sometimes have setæ in them although these are usually few in number. The conidiophores are slender, short, filiform, and hyaline. They bear single, apical, ellipsoid to elongate, one-celled and hyaline conidia. The conidia are easily detached from the conidiophores and germinate by the production of one to three germ tubes. At germination a septum may be formed cutting the conidium into two cells. The distal end of the conidium may produce either a conidium-like body or a chlamydospore-like, dark colored, spherical to oval organ.

5. Under field conditions the fungus produces the perfect stage on the dead infected portions of the host, but it may be induced to form perithecia on artificial media. The characteristics of the perfect stage of the avocado and mango organisms are identical with those of *Glomerella cingulata*. The *Glomerella* of the upo is very closely related to the *G. cingulata* of the avocado and mango, if not identical with it.

6. In the Philippines the imperfect form of the fungus on avocado, mango, and upo is capable of infecting citrus, banana, abaca, pepper, and camias and various other economic plants. From this behavior it appears as though *Glomerella cingulata* has a wide host range as well as a wide geographical distribution.

7. A cool, moist, and shady place is favorable for the development of the disease. Young tender succulent growths are readily infected.

8. Conidia on infected portions are sources of inoculum for both primary and secondary infections. The asci of the ascogenous stage on dead and rotting avocado, mango, and upo leaves, twigs and fruits are a source of inoculum for primary infection. The perithecial stage is also the resistant form capable of tiding the fungus over adverse environmental conditions.

9. The writers believe that under Philippine conditions, insects, meteoric water, and to some extent wind, are responsible for the wide dissemination of the spores of the fungus.

10. The disease may be controlled by careful sanitary measures, control of insects which disseminate the spores, and perhaps protection of delicate tissues with fungicides, and the use of resistant varieties.

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ILLUSTRATIONS

PLATE I

Fig. 1. *a*, *b*, and *c*. Leaves of avocado infected with *Glomerella cingulata* showing that infection starts from the margin of the leaves. The spots merge together forming larger dead areas at the margins of the leaves. About $^2/_3$ natural size. (Photograph by the Bureau of Science, Manila, Philippine Islands.)

Fig. 2. *a*. A fruit of avocado infected with *Glomerella cingulata* showing the early stage of conidia formation. Slightly reduced. (Photograph by the Photographic Division, Department of Agronomy, College of Agriculture, Los Baños, Philippine Islands.)

Fig. 2. *b*. A fruit of avocado infected with *G. cingulata* showing the advanced stage of conidia formation. The fruit is soft and about to crumble to pieces. Note the pale colored masses of conidia covering the entire fruit. Slightly reduced. (Photograph by the Photographic Division, Department of Agronomy, College of Agriculture, Los Baños, Philippine Islands.)

Fig. 3. A small portion of an old infected leaf of avocado showing black bodies consisting of perithecia of *Glomerella cingulata* at points marked ×. The perithecial bodies are produced mostly along the veins. About ×2 natural size. (Photograph by the Bureau of Science, Manila, Philippine Islands.)

Fig. 4. Photomicrograph of a cross section of a leaf of avocado showing a section of an immature perithecium. The section was stained with Flemming's triple stain. ×250. (Photomicrograph by the Bureau of Science, Manila, Philippine Islands.)

Fig. 5. Dead and dry infected stem, leaf petiole and fruit peduncle of upo showing grayish coloration covered with dark colored almost raised dots of the perithecia of *Glomerella*. Slightly reduced. (Photograph by the Photographic Division, Department of Agronomy, Collge of Agriculture, Los Baños, Philippine Islands.)

PLATE II

Fig. 1. *a*, *b*, and *c*. Leaves of mango showing dark brown, circular to oval spots produced by *Glomerella cingulata*. Note that the neighboring spots coalesce and form larger ones. Note also that the spots are more numerous on the young tender leaf in the middle and nearly one-half of the leaf beginning at the tip is infected. About $^2/_3$ natural size. (Photograph by the Bureau of Science, Manila, Philippine Islands.)

Fig. 2. An old infected leaf of mango showing black bodies consisting of perithecia of *Glomerella cingulata* at points marked ×. Enlarged about ×2 natural size. (Photograph by the Bureau of Science, Manila, Philippine Islands.)

Fig. 3. Photomicrograph of a cross section of a leaf of mango showing three mature perithecia in sections. The section was stained with Flemming's triple stain, and the ascospores are heavily stained. Note the arrangement of the ascopores. ×250. (Photomicrograph by the Bureau of Science, Manila, Philippine Islands.)

PLATE III

Fig. 1. Camera lucida drawings of the conidia of the upo *Glomerella*. ×408.

Fig. 2. Camera lucida drawings of a portion of an acervulus of the avocado *Glomerella cingulata* showing conidia borne on conidiophores. ×408.

Fig. 3. Camera lucida drawings of a portion of an acervulus of the mango *Glomerella cingulata* showing conidia borne on conidiophores. ×408.

Fig. 4. Camera lucida drawings of conidia of the avocado *Glomerella cingulata*. Note that the conidia compare in size and shape with those in Figure 1. ×408.

Fig. 5. Camera lucida drawings of conidia of the mango *Glomerella cingulata*. Note that they compare in size and shape with those in Figures 1 and 4. ×408.

Fig. 6. Camera lucida drawings of germinating conidia of the upo *Glomerella* showing the production of chlamydospore-like, dark colored bodies at the distal ends of the germ tubes. Note that two of the conidia produced septa at germination while the other two did not. ×408.

Fig. 7. Camera lucida drawings of germinating conidia of the avocado *Glomerella cingulata* showing the production of chlamydospore-like bodies at the distal ends of the germ tubes and the production of septa of some of the spores at germination. ×408.

Fig. 8. Camera lucida drawings of germinating conidia of the mango *Glomerella cingulata* showing characteristics exhibited by germinating conidia of the upo *Glomerella* in Figure 6, and the avocado strain in Figure 7. ×408.

Fig. 9. Camera lucida drawings of:

a. Asci of the mango *Glomerella cingulata* with eight ascospores. ×408.

b. An ascus in which the ascus wall is not well shown. This type of ascus is frequently found in perithecia of *Glomerella cingulata* from Philippine materials. ×408.

c. One of the paraphyses-like filaments. ×408.

d. A young ascus with a paraphysis-like filament. ×408.

e. Individual ascospores. ×408.

Fig. 10. Camera lucida drawings of:

a. Asci of the avocado *Glomerella cingulata* with eight ascospores. ×408.

b. Asci in which the outlines of the ascus wall are not visible as in Figure 9b. ×408.

c. Paraphyses-like filaments. ×408.

d. A young and undifferentiated ascus. ×408.

e. Individual ascospores. ×408.

Fig. 11. Camera lucida drawings of:

a. Asci of the upo *Glomerella* with eight ascospores as in Figures 9a and 10a. ×408.

b. An ascus in which the wall is not visible as in Figures 9b and 10b. ×408

c. A young and undifferentiated ascus. ×408.

d. Ascospores. ×408.

PLATE I

PLATE II

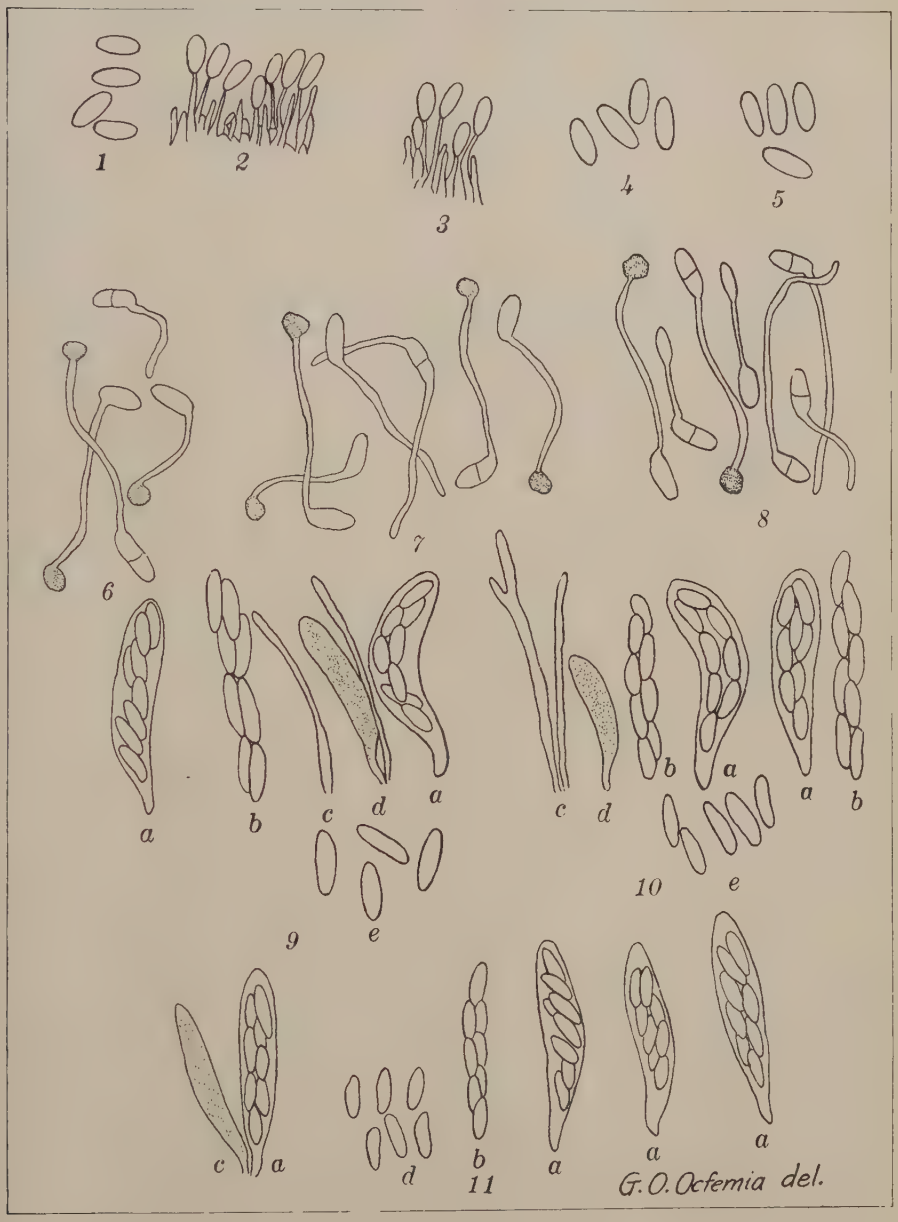

PLATE III

HORSE BREEDING IN THE PHILIPPINES[1]

VALENTE VILLEGAS

Of the Department of Animal Husbandry

WITH ONE PLATE AND FOUR TEXT FIGURES

In 1918, there were in the Philippine Islands 247,528 head of horses representing an aggregate value of ₱18,163,095.00.[2] Because of their varied uses these animals bear an important relation to Philippine commerce and agriculture.

This paper was prepared to meet the demand for information on the care and management of native breeding ponies; and with the hope of helping to improve the type and conformation of horses in the Islands.

TYPES OF OPERATION

Two principal types of operations are applicable under Philippine conditions:

1. The specialized type, on which the breeder depends for his livelihood and income, may be resorted to in regions where extensive rich pastures, preferably on high and rolling elevations, are available. This type entails a large initial outlay and reserve, and a trained and experienced man to carry the venture to success. It is not likely that many will engage in specialized horse raising, but other branches of live stock farming will be included as part of the undertaking.

2. The common, or farmer's type of operation is the one widely in vogue in the Philippines. A farmer owns one or two mares. He usually has a farm to cultivate and other animals to care for. The mares are tethered a good deal of the time and when grass is scanty during the dry season they are supplied with cut forage. In regions affording extensive pasturage on public lands, mares belonging to various owners are allowed to roam and feed without much care.

THE PHILIPPINE PONY

For the purposes for which it is generally used the Philippine pony should approach the coach horse type. That is, he should possess symmetry, style, strength, and sufficient speed with a reasonable amount of knee and hock action. The average native pony lacks proportion in body conformation, but is active and well-spirited.

Generally the Philippine pony is undersized, the usual height being 124.5 centimeters (49 inches) and the weight, from 180 to 225 kilograms (397 to 496 lbs.). It should be the aim of the breeder to secure greater size in his animals. From 127.0 to 134.6 centimeters (50 to 53 inches) in height and a weight of from 225 to 275 kilograms (496 to 606 lbs.), is desirable.

It is not uncommon to find Philippine ponies exhibiting animated, free, and regular action. That is, the legs are lifted up high and with snap, showing style,

[1] Experiment Station contribution No. 306. Received for publication, May 10, 1925.

[2] Census of the Philippine Islands (1918), Volume III.

yet with ample extension to cover proper distance. Looking at the animal from in front or from behind, the legs move straight, looking at it from the side, the stride is regular, high, and performed at a rapid rate.

In temperament, the horse should be sanguine and courageous. But he should not be excitable or easily frightened. As it is an animal of service, the horse should be safe and reliable, a willing worker and free from dangerous vices, such as kicking, biting, pawing, rearing, and balking. Generally speaking, the Philippine pony can be depended upon as a safe and willing worker.

A well proportioned and nicely carried head is desirable. To indicate good breeding and quality it should taper finely towards the mouth, but the muzzle should be well developed and medium in size, showing that the animal is a good feeder. There should be sufficient width between the eyes and the forehead should be broad and prominent, points that bespeak intelligence in a horse. The eyes should be bright and full and free from coarseness; such eyes denote a good disposition. The ears should be medium in size, pointed and alert. To provide for a roomy passage of food and respiratory canals the space between the lower jaws should be wide and clean. The nostrils should be wide open, fine, and capable of wide dilatation; points true with animals of sound and vigorous respiratory capacity. As a whole, the head should be well-chiseled and fine. On the average, the head of the Philippine pony is large and plain, and indicates lack in quality and deficiency in intelligence.

The neck should be well-carried and the length should be in proportion to the body of the animal. It should be fairly well-muscled. In the case of stallions the crest should be well developed, indicating marked sex character, while with mares a straight neck is desirable. Usually Philippine ponies are coarse at the neck, particularly at the throatlatch.

The withers should be level with or higher than the loin. They should be fairly well-muscled and smooth and set well back.

The Philippine pony, as a rule, is well developed at the fore quarters. The shoulders should be deep and oblique affording sufficient depth for the development of a sound respiratory system. There should be a good covering of muscles over the shoulders giving a smooth appearance to this part of the body.

The body should present a deep and moderately wide chest and good barrel as these indicate good constitutional vigor. The ribs should spring more or less horizontally from the back, be deep and set close together. The back should be short, wide, and well-muscled. The flank should be well let down and full. Between the last rib and the point of the hip the so-called "hunger hollow" should appear small, showing strong coupling. While the Philippine pony excels in the development of the chest cavity, the ribbing is generally poor, making the animal appear slab-sided. Many individuals are also short-bodied. In most cases the belly is paunchy, largely due to overfeeding on grass.

The loin should be wide and muscular but short. Strength of body and boldness of action are obtained with a short, strong loin.

The hind quarters form a most important part of the horse structure. This part of the body is the propelling power of the animal and hence should receive due consideration. It should be characterized with ample muscular development, width, length, levelness, and depth. The croup should be level, muscular, and wide. The hip and thigh, including the lower thigh, or gaskin, should also

be wide, deep and muscular. The majority of native ponies are deficient at the hind quarters. To correct this fault, whenever possible, breeding stallions extraordinarily developed at this part should be selected.

The tail should be carried high and well placed to give style and symmetry to the animal.

Of paramount importance is the underpinning of the horse. As the horse is highly prized for action, or speed, the character of the legs and feet should be given special attention. The legs should be characterized with strength and yet possess quality. The forearm should be long, wide, and muscular. The knee should be clean and strong. It should be wide, straight, deep, well supported, and in proportion to the rest of the body. Too large a knee indicates coarseness, while small knees are weak. The cannon bone should be clean and short and behind it the tendons should extend deep and should be clean and straight. Greater emphasis should be given to the hock, its structure being more complex and the work it does more strenuous. It should be proportional in size, clean, wide, deep and long, and well supported. In a good hock there can not be undue coarseness. The pastern should be wide and clean, and sufficiently long to produce springiness of action. It should slope 45 degrees from the ground. Sound, well developed feet are necessary for efficient performance of the animal, especially with horses used on hard roads. The feet should be large, fairly concave, with well developed heels, sloping at an angle of forty-five degrees. The horn should be dense and waxy. A black hoof is believed to be more durable than a white one. In formation of legs the native horse may be highly commended. In spite of the hard work demanded and the poor care given, comparatively few Philippine horses become unsound in the legs.

Color in horses is deemed highly significant in estimating the price of an animal. It is thought to have influence on the performance of the animal, particularly on its stamina. Color is an important factor in the appearance, in the beauty of the horse.

The preference for certain colors varies in different parts of the world. In the Philippines, horsemen prefer bay, brown, and gray to other colors. Buckskin is also held in high esteem. Horses of these colors are highly resistant against the effect of the sun's heat. Black, red roan, and cream are rated as second in preference; while horses that are blue roan, mouse color, or of mixed colors as piebalds and skewbalds, are regarded as undesirable. Albino is objected to on the ground that horses of this color are weakened easily when working exposed to the sun.

It is, of course, important to breed for such colors as are valued by horsemen, but this should not be followed at the expense of other more fundamental characters of the animal.

FAULTS OF CONFORMATION AND UNSOUNDNESSES

Breeding horses, whether stallions or brood mares, should be as free as possible from such unsoundnesses and faults of conformation as may affect, seriously, their usefulness.

An animal possessing an extremely narrow and coarse head, indicating low intelligence and inferior breeding, should be discriminated against. An animal characterized with coarseness and loose joints, or one that is a "weedy" individ-

ual lacking in substance and constitution, consequently appearing leggy, upstanding, and narrow, should be considered undesirable. Crooked legs are not favored, because legs that are not in the normal straight position will go wrong in action and detract from the efficiency of the animal and may lead to the development of certain blemishes or unsoundnesses. Thus, a horse that toes-in, will swing its feet outward as in paddling. Some individuals go narrow at the hocks, sometimes so badly as to strike at the hocks in motion; however, a horse better be moderately narrow at the hocks than be wide. Straight and short pasterns constitute a weakness, as such a conformation is unpleasant to the rider and may lead to the formation of ring bones. Club feet as well as flat feet are very undesirable. The club feet afford very little space for the development of normal, sound frogs, and lead in time to contracted feet, while flat feet are weak and likely to contract corns and lameness. Disproportionate size of feet, especially when undersized, is a serious defect.

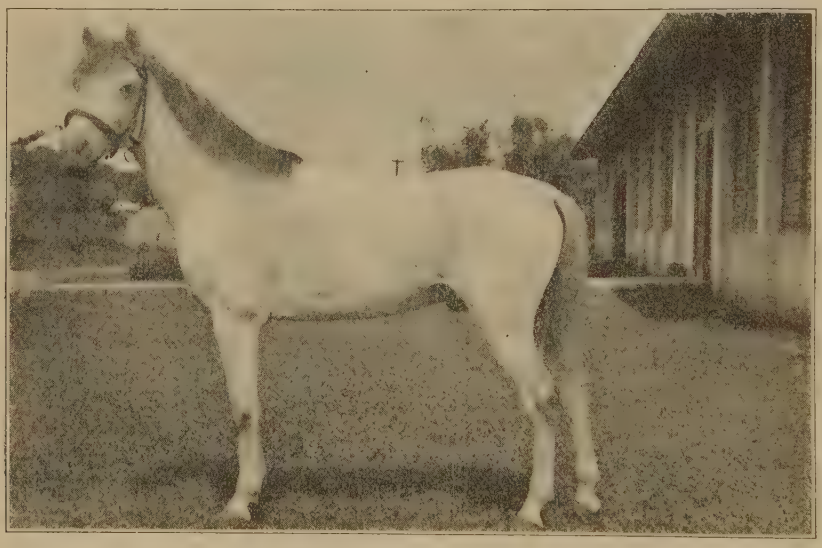

Fig. 1. A breeding stallion showing masculine character, size, quality, and desirable conformation.

The stallion should always be free from unsoundnesses of any kind, particularly osteoporosis, ring bone, side bone, curb, bone spavin, blindness, stringhalt, roaring, or heaves. Any unsoundness accompanied with faulty conformation as predisposition should be condemned. Generally, brood mares affected with unsoundnesses of one kind or another may be used for breeding purposes, provided the unsoundness is not accompanied with faulty conformation of the part affected. However, such unsoundnesses as osteoporosis, stringhalt, blindness, roaring, and heaves should, as a rule, debar a mare for breeding purposes.

THE STALLION

On the stallion depends one-half or more of the improved quality of horse flesh in a community. The selection of a stallion should be primarily from the business aspect of the horse industry, not from the esthetic point of view. A stallion possessing the right attributes commands value and popularity among

the breeders so that its maintenance becomes a highly paying proposition, as well as a matter of pride to the owner. Accordingly, care and the best possible rigid judgment should be exercised in the selection of the proper individual to be used to head the stud.

Masculinity

Besides conformation, temperament, and unsoundness, sex character should be considered in the stallion. It is believed that the more masculine the animal the greater his ability to transmit his characteristics to his get. As a mark of masculinity, his front should show vigor and boldness of feature. The head should be rugged, yet intelligent and neat; the eyes should be bright and full without showing mean or vicious tendencies; the neck should be thick and with a prominent crest and should be carried high and proudly. It should be neither short nor coarse. The muscling over the shoulders and withers should be well developed yet smooth, thus combining in the animal a front that is rugged, vigorous, and aggressive.

Fertility

It is not uncommon to find a stud horse that is low in fertility, that is, incapable to "settle" mares brought to him for breeding. And it is not unusual to find individuals that are absolutely infertile. Hence, it is important to examine the semen of stallions that are selected for breeding purposes. Under the microscope the sperms must appear in great number and all should be very active. If the stallion has been used for breeding, investigation as to the general percentage of get produced from his services should be made. Also, the genital organs should be examined. The penis and testicles should be normal in size and healthy. Cryptorchids or ridglings should be debarred.

Prepotency

The greatest benefit from a stallion is obtained when he is capable of transmitting to his offspring his characteristics to a large degree, or, better still, if the majority of his get turn out to be superior to the sire or dam as a result of proper blending of the desirable attributes of both the stallion and the mare. As a general rule, the more masculine and energetic the individual the more prepotent he will be. But the best test for prepotency is to study the progeny of a breeding stallion.

Breeding age and services

The stallion may be started to breed as young as three years of age. Early breeding tends to develop the masculine characters of the animal, moreover, he may be trained more readily to serve mares properly. But at this age, the services should be limited to a few mares. About twenty-five mares will be sufficient; fifty mares at four years of age; and no more than two services a day with mature stallions. Young horses when used for breeding at an early age are likely to become stubborn and vicious. To guard against this the stallion should be handled regularly and often, and trained to obey orders so that breeding may be done without difficulty.

Feeding and management

The stallion is the most valuable animal in the stud and should be accorded the best attention and care. The feeds and manner of feeding require proper supervision to attain optimum results. A medium flesh and high spirit in the animal should be maintained. A run-down, haggard, or otherwise unhealthy individual is likely to produce weak sperms or his capacity to serve mares be very limited, while a gluttonous fat stallion lacking in exercise is sluggish and may turn out to be sterile or a poor breeder.

Corn and rice bran may be depended on as the mainstay in feeding stallions. A small amount of copra meal in the mixture will improve the quality of the grain, but an excessive amount of this feed is likely to produce harmful effects, besides rendering the combination unpalatable. A grain mixture composed of five parts shelled corn, five parts rice bran, and two parts copra meal is recommended. Or, five parts of rice bran and two parts of shelled corn and one part of copra meal is also desirable. However, as copra meal is generally not available locally and its price is sometimes high, its use may be dispensed with. When corn and rice bran are used alone each may constitute fifty per cent of the mixture, but at times the price of corn is so high that the bulk of grain feeds must be in the form of rice bran. Rice bran may be fed as the only grain constituent of the ration, especially if it is given in the form of mash or wet with molasses water. But shelled corn should be furnished occasionally on account of its fattening quality and high palatability.

No hard and fast rules can be laid down as to the amount of grain to be fed, but, as a rule, a stallion may be given about one kilogram of concentrate for every 100 kilograms of live weight. If the animal is rounding up too much and becoming sluggish, his exercise or work may be increased or the feed reduced. If he is going down in flesh so that the ribs and prominent bones begin to show up, or when breeding services are in great demand, the grain ration should be increased, and if he is worked he should be used rather sparingly. Care should always be exercised that he does not go off feed. When feed is left in the manger at any feeding time such left-overs should be removed immediately and the next feeding should be so gauged that only the amount is given that the animal will consume readily.

For roughage, Guinea grass (*Panicum maximum* Jacq.) and barit (*Leersia hexandra* Siv.) may be given. These grasses are much relished by horses, as they are very palatable and fine in texture. They can be grown throughout the year under cultivation and their yields are high. From fifteen to twenty kilograms of zacate is a good daily allowance for one horse of average size. Ordinarily barit is put up in bundles, one hundred bundles making up a bale weighing fifteen to twenty kilograms.

Other grasses that may be fed green to the stallion are corn forage and such pasture grasses as young cogon (*Imperata cylindrica* Linn. Beauv.), gutad (*Digittaria corymbosa* Roxb.), Bermuda grass (*Cynodon dactylon* Linn. Pers.), pulang puet (*Panicum colonum* Linn.), culape (*Paspalum conjugatum* Berg.) young aguiñgay (*Rottbœllia exaltata* Linn. f.), young Napier grass (*Pennisetum purpureum* Schum.), Para grass (*Panicum barbinode* Trin.), barili (*Panicum stagninum* Retz.) and bayakibok (*Panicum crus-galli* Linn.). The prime requisites in forages for horse feeding are palatability, nutritive value, fine texture, healthful

effects, high production, availability and cheapness; the forages listed above possess a number of these features.

In some localities corn forage is sold in bundles of varying sizes, while gutad and Bermuda grass are packed in sacks. Barili and bayakibok are usually sold in bundles four or five times the size of the bundles of barit. These bundles are also tied together into bales.

Among hay forages, rice and peanut hays may be produced successfully and both are well liked by horses. Being a legume, peanut hay furnishes rich nutrients for feeding purposes.

Feeding should be done three times a day—morning, noon, and afternoon. As to the amounts to be fed to the stallion at different times of the day the following schedule may be adopted:

Morning.....3/8 of day's grain, 1/4 of day's roughage.
Noon.....3/8 of day's grain, 1/4 of day's roughage.
Night.....1/4 of day's grain, 1/2 of day's roughage.

Morning feedings should be as early as possible; the night supply should be given about six to eight o'clock.

Watering is just as essential as any phase of feeding operations. Spring or deep well water has the best cooling effect on the system of the animal, and only water that is sanitary and clean should be given. Watering before and after giving the grain and roughage is advisable.

The stallion should be supplied with salt regularly, especially when stabled and cut off from freedom of the pasture. Common granulated salt given three or four times a week, a handful each time, will be sufficient. There is a continuous drain of this mineral from the body and the loss must be made up. Furthermore, salting stimulates the appetite of the animal.

If the stallion fails to improve in condition in spite of good feeds supplied to him, or if he insalivates and evinces difficulty in mastication, the teeth may be suspected as the cause and should be examined. Where a tooth is broken or decaying, it should be extracted by a veterinarian. If sharp points are felt on the surface of the molars these should be rasped or "floated."

Housing

Housing depends often on the temperament and disposition of the stallion and general conditions in a stud. The stallion may be kept either in a boxstall separate from the stalls of other horses or among the mares and other horses under the same roof. To provide for a separate shelter and paddock for the stallion involves extra expense for the construction of the shed. It means also waste of time and inconvenience for the groom. On the other hand, the separate paddock arrangement would be safer for the stallion and the other horses and there would be less of the annoyance that usually obtains with the stallion being housed with other horses, especially mares. To put the stallion in a boxstall side by side with other horses in the same barn has its advantages. The stallion once trained to live among others of his kind will be easier to control and manage. In any case it is recommended that the stallion be kept in a boxstall where he is free to move and feed comfortably. The studheader is different from a work horse in that he is idle most of the time and so requires continuous exercise to keep his body in breeding tone. The boxstall may be $3 \times 3\frac{1}{2}$ meters in size.

The walls should be of six-inch boards nailed vertically, 5 centimeters apart. The height of the wall should be from 2 to 2.2 meters. The space allowed between boards provides for free passage of air, rendering the quarters more ventilated and sanitary. Such an arrangement also enables the stallion to see the other horses outside, which is beneficial for an animal in confinement. There should be no space or opening large enough for the feet of the stallion to go through at the bottom of the walls of the boxstall. The door should be at least 90 centimeters wide and 1.75 meters high. The floor should be of clay packed hard before using. Over this, bedding in the form of sawdust, sand, cogon or rice straw may be used. The bedding should be cleaned and dried every morning to keep the place healthful and free from objectionable odor. The bedding may be used over and over until it is dirty, disintegrated or polluted, when it should be changed for fresh material.

The door from the boxstall should open into a paddock where the stallion may have freedom to walk or trot. Such a run may be 20 by 30 meters in size. A very small paddock is unsatisfactory as the stallion will not be able to run or trot for exercise, while a spacious enclosure will encourage a highly spirited animal to run excessively to the detriment of his health. If it is not practical to locate the paddock adjoining the boxstall a separate run may be built. A shed may be put up in the enclosure to afford shelter from the intense heat of the sun and from rain.

Exercise

With a paddock of a reasonable size provided, the exercising of a stallion becomes a minor problem. As a matter of fact, when the weather is unfavorable or when work is pressing in a stud the stallion that has the freedom of a paddock need not be taken out for exercise. As a general proposition, however, the stallion should be trotted, slowly, two or three kilometers a day, ridden or driven. A stallion so exercised behaves better and may be used in this way with profit. The amount that the stud-header may be ridden or driven depends upon the number of breeding services he is rendering, but in no case should his condition be allowed to run down so as to reduce his vigor and procreative power. A lifeless, weak individual is unattractive and apt to be inefficient as a breeder.

Shoeing

Except in regions where there are no roads, the stallion should be shod at least once a month. The hoof should not be allowed to grow overlong so as to make his action unbalanced or the placement of the legs crooked. Neglected, twisted legs have the tendency to develop certain unsoundnesses or to render the action faulty. Feet that have to go without shoes should receive regular trimming and leveling so as to keep the hoof level and normal in shape. The edges should first be cut with a pair of pinchers or a hoof knife and afterwards smoothed by means of a file or rasp. The ragged ends of the frog and bars should be cut with the hoof knife, but they should never be trimmed heavily. This is a mistake commonly made by farriers.

Grooming

In every stable there should be handy a curry-comb and a brush, as well as a comb. The stallion should receive thorough grooming twice a day. To clean the animal and leave the bottom line and depressions without being brushed

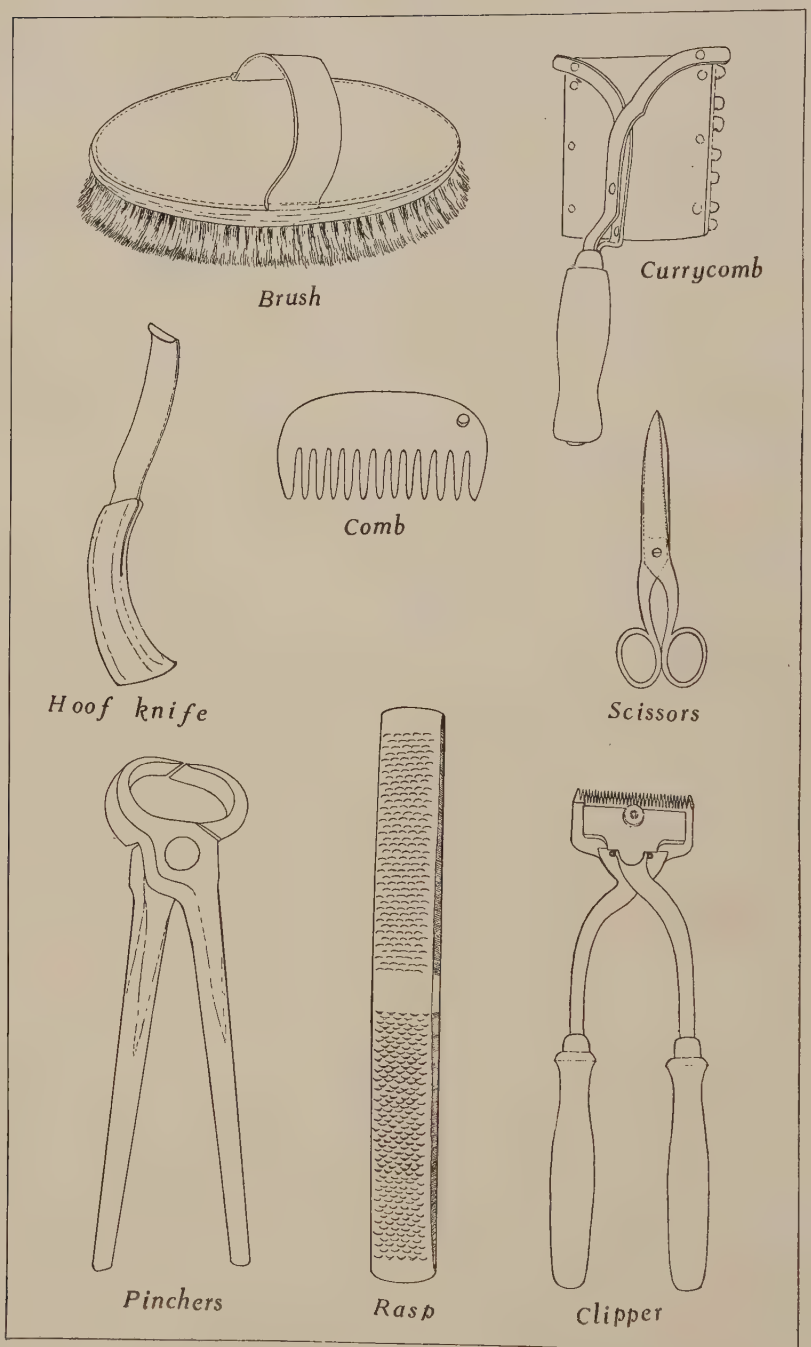

PLATE I

Tools for cleaning and trimming horses

over is work half done. On the other hand, avoid passing the teeth of the curry-comb on the bony parts of the animal; use the brush instead. To impart lustre and smoothness to the hair, a piece of clean rag moistened with a little coconut oil may be passed over the body of the animal. As part of the routine, morning and evening or before and after using, the feet should be gone over and the hoof pick used to remove foreign material lodged in the crevices of the hoof. With white or light-colored horses, it is often necessary to wash with soap and water the parts that are badly soiled with dung or dirt.

Bathing

During long periods of warm weather it is very soothing to the stallion to give him a bath. But on rainy or cold days bathing horses is not advisable, except with the object of cleaning an animal that has lain down in mud or otherwise has become very dirty. In giving a horse a bath a brush or the smooth edge of half a coconut shell (*bao*) may be passed over the body to aid in removing dirt and dandruff. Parts that are badly stained may be soaped. The hollows of the body such as between the lower jaws, above the eyes, the armpit, between the quarters, above the hocks, and back of the pasterns should be thoroughly

Fig. 2. A brood mare. Note her refinement, size, and good conformation.

cleaned. In like manner, the head, bottom line and the hoof, which are often neglected, should receive proper attention. In some localities grooms claim to remedy the stiffness or rheumatic condition of the legs of horses by swimming them in deep lakes or rivers.

Finally, to put the stallion in good show condition, the mane, foretop and tail should be properly trimmed at all times. Generally, these are allowed to grow in the stud-horse. The hair should be combed as part of the daily grooming and cleaning operations. Unsightly bristles on the lower jaw and hair on the fetlock and back of the pasterns should be clipped regularly.

THE BROOD MARE

The common idea of depending almost wholly on a superior stallion to produce good offspring out of nondescript mares is folly. The mare has just as

much influence on the make-up of her progeny as the stallion, so her selection should receive proper consideration.

Femininity

A brood mare may be ideal in conformation yet may fail to reproduce regularly or not at all because of masculine tendencies in her traits. It is important then that she shows marked femininity as an indication of reproductive propensity. This characteristic is shown in general refinement throughout the body, the animal appearing to be long, fine and mild rather than stocky and bold. The head should have a sweet maternal appearance and the neck be light and neat. At the hind quarters she should be highly developed; that is, she should be wide, deep, level and long at this point, thus giving roomy quarters for the development of the fetus. The vulva should be normal in size and position, and healthy. The greater the development of the mammary glands the more likely is she to be good as a mother.

Age of puberty

The first œstrum appears in mares at about one year of age. Unless the mare is exceptionally growthy and well developed her breeding should be delayed until she is about two years of age. The mare bred at this age develops feminine characters early enough, yet not so young as to stunt or interfere with the normal growth of the animal. The next breeding season she may be rested to allow for progression of body development until maturity is reached when she should be again bred. Following this she may be bred every year without causing harmful effects on her constitution and vigor. Some mares that are brought for breeding late in age may reject the stallion, even after repeated trials, and appear as though they are bred. If after thorough observation and examination such mares prove to be open they may be forced by the stallion. After this they will likely receive the stallion in 18 to 21 days.

Signs and recurrence of heat

The mare that is in heat is generally restless and playful. If a stallion is near by and shows desire to breed, the mare in heat raises her tail, urinates, and the lips of the vulva open and shut regularly at intervals. Ultimately, the "horsing" mare will bring her hind quarters towards the stallion in a breeding position. The period of œstrum lasts for about five days each time and recurs every twenty-one days. Just after parturition, the mare comes in heat in eight or nine days. It is best to watch for these periods and to breed mares then.

Method of breeding

By following a system in breeding operations much annoyance and loss of energy of the stallion are avoided. The safety of the animals and attendants is also insured. The mare, whether apparently in heat or not, must be hobbled. The hobbling of mares that are known to be absolutely quiet when "horsing" may be dispensed with. One of the signs of œstrum is the receptive mood of the mare towards the stallion, but some mares are so exceptionally spirited and nervous that even though in heat they may kick at the first approach of the stallion. While indications of œstrum may be present, yet, to be sure, it is advisable to have her teased with an inferior stallion of the stud known as the "teaser." The

teaser is brought towards the mare, preferably towards the flank. The mare is curious about the stallion coming to her and therefore will likely remain more quiet than if the stallion is brought directly from behind. The stallion sniffs at the flanks and if the mare is in heat she raises her tail, urinates or opens the vulva and poses to receive the stallion. She may kick the first time, but usually subsides afterwards and remains quiet. The studhorse is then brought and walked around at a reasonable distance from the mare until the copulatory organ is out and ready when he is directed towards the left side of the mare and allowed to cover. The groom takes hold of the mare's tail with his left hand while directing the penis to the vulva with his right hand. Before copulation the vulva may be smeared with a little vaseline or coconut oil but mares with large genital open-

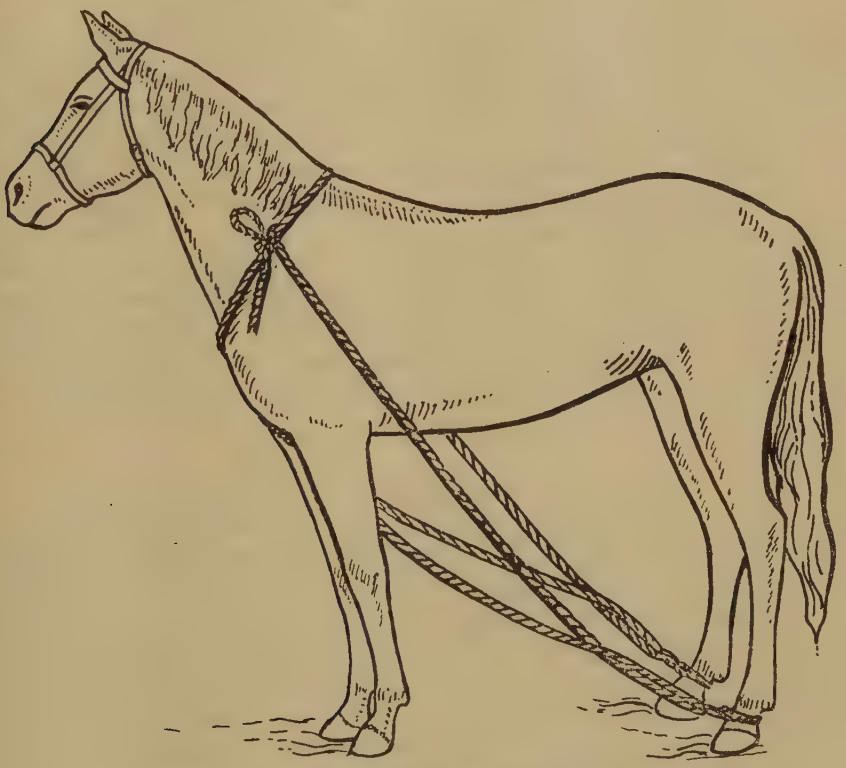

Fig. 3. A mare hobbled with a casting harness for breeding.

ing require no such treatment. The stallion is encouraged to stay on top of the mare by patting him on the back until the service is over. Small, thin, weak mares usually find difficulty in supporting the weight and push of the stallion and should be aided by putting one's shoulder against the neck of the mare to prevent her from falling down.

Oftentimes mares are brought to the stud with foals on the side, especially when the mare is to be bred nine days after foaling, which is considered the best time to breed her. In such cases, to prevent the foal from being kicked or trampled by the stallion a small enclosure for the foal may be put up on the breeding ground within sight of the mare. To keep the foal out of her sight may cause an irritable mare to reject the stallion even though in heat.

After the breeding operation is over it is good policy to wash the penis with a disinfectant or clean water. In breeding outside mares, use disinfectant to prevent the infection of the stallion with disease germs that the mares may harbor. But in breeding mares that are known to be free from diseases, the use of germicide is not necessary; instead, clean water with a little soap may be used to rid the penis of the sticky matter adhering to it after the service.

After the service the mare should be led out slowly. Mares that are trotted out after the service are likely not to "catch." If the mare is from a long distance it is advisable to keep her in the neighborhood until after she has been brought to the stud two or three times and has rejected the stallion, when she is pronounced bred.

Signs of pregnancy

An almost infallible sign of a mare in foal is the cessation of œstrum. There are, however, other indications to be seen in a pregnant mare. Her abdomen increases in size, she fattens more readily, she is either crosser or milder in temperament than usual and has the tendency to keep separate from the rest of the herd. As pregnancy advances the abdomen becomes more pendulous and larger. The heavy weight bearing on the abdomen causes the back to sag more than ordinarily and the croup to appear more drooping than normal. A few days previous to parturition the ligaments of the pelvic region relax and accordingly a depression is noticed on both sides of the croup just above the tail head. Also, about the same time, a waxy covering may be formed at the tips of the teats and the udder becomes fully distended. As soon as watery secretions are observed to flow from the swollen udder the foal may be expected in twenty-four hours.

The period of gestation is approximately 330 to 340 days or about 11 months.

Feeding and care

Brood mares may be used for light work on the farm or be kept only for breeding purposes. Whenever it is practicable, brood mares should be worked not only to derive extra returns from them but also to render them more tractable and to keep them in better health. But in no case should a pregnant mare be overworked or used on upgrades or made to plod through deep mud, nor should she be made to pull a heavy load. A common and desirable method of keeping breeding mares is to stable them, tethering them whenever possible, and use them as pack animals to transport farm products to the market at regular intervals. Mares so treated get individual attention and are usually in good condition and well-mannered.

Another method is to turn out mares in large herds on large pastures. Usually, such mares thrive well on luxuriant and rich pastures, but when large numbers have to be attended to it is almost impossible to give individual attention to them and at the same time receive paying returns from the business. Such mares are likely to be wild and difficult to handle. To render them more tractable they should be brought to a shed daily for grain feeding, salting, and grooming. Each is haltered and as much handling is given to them as possible while they are groomed and fed.

In a well managed stud, brood mares are turned loose in paddocks provided with shelter. Such paddocks should have plenty of good grass all the time; as soon as the sod runs down the mares should be put in fresh lots. The size of such

pastures depends upon the number of animals, but in all cases each lot should be large enough to permit plowing inside the enclosure. When the paddock is very weedy, "stale," or otherwise unfit for the growth of good grass, it should be plowed, and planted with corn or other forage crops, so as to promote the growth of new grasses.

Dry mares do not as a rule need any grain feeds so long as the pastures are well maintained and furnish rich forage. However, during the later stages of pregnancy some mares need grain to supplement the pasture feed. Suckling mares should always receive concentrates if both dam and foal are to live thriftily. Corn is the best single grain feed for this purpose, but owing to its high price rice bran is to be preferred. But corn should form part of the mixture, whenever possible, to add variety and improve the palatability of the concentrate portion of the ration. A mixture of three or five parts rice bran and one part of corn is recommended. The mares may be fed once a day, the amount depending upon the condition of the animals. A mare with an older and vigorously growing foal will require more grain supplement than one with a younger and smaller foal to feed. Usually two to three kilograms of grain daily will suffice for each mare.

Besides grooming, a mare's feet should receive proper attention. A mare that is regularly used should be shod, while those kept in paddocks most of the time should have the hoof regularly trimmed. Idle mares do not sweat profusely and so do not need bathing. But to put them in presentable shape the fetlocks should be clipped and the mane and tail combed regularly.

Care of foaling mare

Within a month of the foaling date the mare should be observed often. At this time she should be kept away from the rest of the herd and placed in a foaling boxstall or pasture. A foaling boxstall should be about $3\frac{1}{2} \times 3\frac{1}{2}$ meters. Before putting the mare in the boxstall the floor and walls should be disinfected by spraying with a three per cent creoline solution or other disinfectant. Any layer of manure or putrefying organic matter on the floor should be scraped off thoroughly and removed from the place. The floor should be bedded with a thick layer of clean rice straw or dry cogon. During dry weather fresh paddocks afford the most sanitary place for foaling.

While in labor the mare should not be interfered with and the attendant should place himself at some distance from her. But constant attention should be directed to her, especially with a valuable mare. As a rule, the fetus is out in about ten minutes from the time the mare starts laboring. Undue delay in the delivery of the young should be considered serious and a competent practitioner should be secured to help the animal. A delay of four to five hours in the expulsion of the young will likely mean a dead foal.

The mare after parturition is fatigued and uneasy. Do not bother her until she has rested. She needs some kind of cooling and strengthening feed. Rice bran with water and mixed with a little salt is a good feed for her as soon as she will take it. Cool water should be placed before her.

The afterbirth and blood matter on the ground should be removed from the place and buried deep in the ground, and air-slaked lime sprinkled over the

surface. The hind parts of the mare should be cleaned and wiped with a rag dipped in a disinfectant. The teats should be wiped with a clean rag before the new-born colt sucks the first milk.

Care of the young foal

Just after parturition observe the newly born foal very closely and see that it gets its first breath immediately. If any phlegm covers the nostrils and prevents the animal from breathing, rush to him and remove it. If after this, breathing does not set in, work the ribs and rub the body with dry straw or a dry clean piece of rag. Generally, however, a healthy foal at birth is free from mucus on the nostrils and gets its breath soon after delivery. The dam, if undisturbed, will soon lick the new-born all over the body.

The umbilical cord of the foal tears off whether the mare delivers in a recumbent or in a standing position. After foaling the caretaker should paint the cord with tincture of iodine or any other strong disinfectant. This may be repeated if the cord does not dry out readily.

The foal should receive the first milk, or colostrum, of the dam. This is very necessary to remove the meconium lodged in its system. If the meconium is not expelled early enough, the foal will be dull, drooping, and sleepy. In this case, give the foal sixty grams of castor oil and an enema of warm water containing a little glycerine. The treatment may be repeated if the meconium is not passed within six hours.

The foal is generally allowed to suck the dam for five or six months. Foals of exceptional value may go with their mothers for a longer period of time provided the latter are good milkers. To obtain the best growth in the young the dam should at all times be well fed and kept in good condition, especially during the latter stage of lactation when the demand of the foal for milk is greater. When about a month old the foal will start nibbling on grain and may be allowed to eat with the mother from a low feed box. When he is about three months old all that he will consume readily at each feeding time of the same mixture of concentrate that is fed to the mare should be given to him once a day. A "creep" or inclosure which will allow a foal but not the mare to go through may be built, inside of which the concentrates may be placed in a feed box for the foal.

Foals of working mares may be separated from the mother at intervals of two or three hours, depending on the age of the foal. But in no case should the foal be allowed to suckle a heated mother. If possible, two or more foals should be put together in a barn for company when the dams are taken away for work.

The first training that a young foal should receive is learning to be handled. At first it is easily frightened and wild. Begin by placing the hands on the fore and hind quarters. The hold should not be so tight as to induce the animal to jump up and run away. By repeating this treatment several times the foal will become docile and easily managed. At the same time a cotton rope halter should be fitted on the head to which a 15-cm. piece rope is connected and allowed to hang. The foal may be caught easily by this rope. By connecting this with another rope he may be taught to lead by pulling him in front and having some one to coach him to go with the noise of a whip. The body should be gone over as often as possible with the brush. The sensitive parts such as the head, belly, and between the quarters should be handled. The feet should

be lifted now and then and cleaned; whenever necessary the hoof should be trimmed so as to keep the leg placement level and normal.

As soon as the hair has grown excessively long the body may be clipped all over except at the tail. The hair on the pasterns and fetlocks may be clipped by lifting up the feet and using the small hand clipper.

METHOD OF WEANING

Mention has been made that a valuable foal may be allowed to go with the mother until it is naturally weaned.

As a rule, however, foals are weaned artificially. Two systems are followed. The foal may be weaned either gradually or separated from the dam outright. If the dam is to be in sight of her young now and then the first method is recommended. The foal is allowed to suckle the dam twice or more times the first day, gradually lengthening the intervals until the udder of the dam becomes dry. Weaning by the second method is preferred. The foal is separated from the dam and, if possible, is not permitted to see its mother until it is completely weaned. Meanwhile the udder of the dam should be dried up by gradually lengthening the intervals between milking and leaving a little milk in the udder at each milking until it will no longer swell.

The boxstall in which the foals are kept should be a well-constructed enclosure. It should have sides high enough to prevent the foals from jumping over and be free from ledges on which they could bump themselves.

Care of weanlings

Weanlings, males and females, may be kept together in paddocks until the age of puberty, or one year old. At this age the colts are separated from the fillies. To obtain good growth and development, each should receive about one kilogram of grain daily. They should be kept in rich pastures; during the dry season when grass is scanty and poor, zacate may be given them. In the shed when they are grain-fed they should be haltered and the body should be groomed. The feet should be trimmed and kept level at all times.

If the weanlings are exceptionally growthy, training may be started at two years of age. But as a rule they are trained at two and a half to three years of age. The work should be light during the first year. All horses should be taught to carry the saddle, and saddle horses should also be trained to pull a vehicle.

Before a weanling is sold it is best to have him trained for the particular service to which he is to be put. Besides the training, improvement in the condition of the animal adds much to its value. He should be stabled and given fattening feeds so as to round up the body and improve the symmetry and general appearance. If long-haired, the body should be clipped and the mane and tail should be trimmed. The long hair on the lower jaw and back of the pasterns and fetlocks should be clipped. The feet should be leveled and rounded on the edges. Much can be done to add to the selling value of an animal if it is taught to stand elegantly and squarely on its legs, and if it has been so handled as to be free from bad or vicious habits.

CASTRATION

There is an utter lack of appreciation among Filipino horsemen regarding the merits of castration of work horses. In fact, there exists a prejudice against the operation for it is the general belief that castration renders an animal sluggish and weak.

Castration of calesa or other work horses should be encouraged, for by resorting to this practice the usefulness of an animal is very much increased. Unruly and vicious stallions should be castrated. An unsexed horse keeps and fattens more readily; also, he is a more willing worker and a safer animal to handle. If the stallion is unfit to reproduce his own because of poor conformation or other defects it is evident that castration is the best means to check its procreative power.

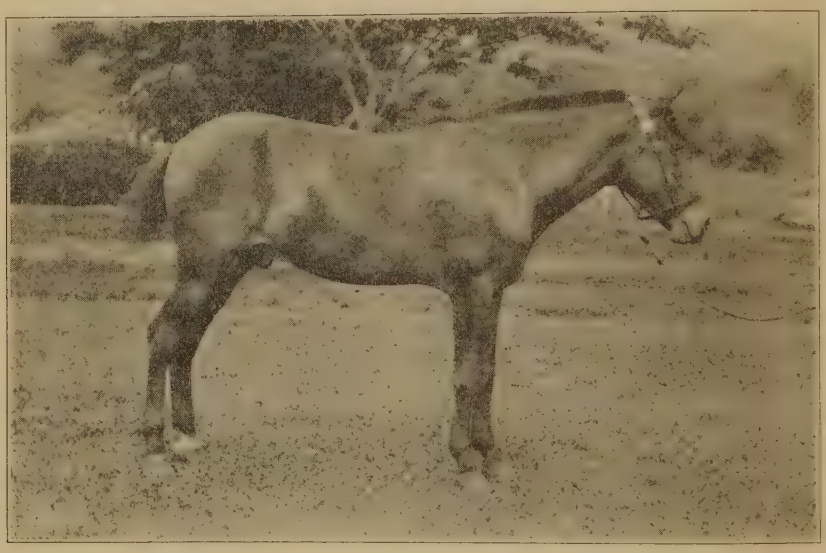

Fig. 4. A gelding as gentle as he appears. Before he was castrated he was so vicious that he could not be used with safety.

The proper time at which to castrate a work horse is between two and four years of age. It is the aim to allow for sufficient development of masculine characters, yet not too advanced as there is greater danger in the castration of older animals.

Preliminary to castration the animal should be fasted for about 18 hours. The necessary instruments and drugs should be prepared. These include one casting harness, ten meters of ½ inch rope, one scalpel or penknife, one emasculator, half a bucket of 3 per cent creoline solution or other disinfectant, and a mixture of tar and vaseline in equal parts.

The stallion is fitted with a casting harness and thrown down on the left side. The four legs are tied together as securely as possible. With one man at the head, the operator places himself behind the horse and disinfects the area of operation. The skin of the lower half of the scrotum is then cut. The incision is made to the testis alongside the median line separating the two halves of the

scrotum. The testis is afterwards pressed out. The appendages are separated from the spermatic cord to which the emasculator is applied. The emasculator must be so placed that only about 1 to 1½ inches of the cord is left with the testis and that the serrated edges are directed towards the body of the animal. The instrument must be left on the cord long enough to insure its full effect. The same method is followed with the upper testicle. Throughout the process the instruments and organs of the animal must be kept under aseptic conditions. After the operation the parts surrounding the wounds should be painted with tar-vaseline mixture to keep off the flies. The scrotum should be observed every day, and whenever necessary it should be disinfected and the vaseline-tar preparation applied on it. Within two weeks the animal should be in condition to resume work.

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ILLUSTRATIONS

Fig. 1. A breeding stallion showing masculine character, size, quality, and desirable conformation.

Fig. 2. A brood mare.

Fig. 3. A mare hobbled with a casting harness ready for breeding.

Fig. 4. A gelding.

APPENDIX

A guide to determine the approximate date of parturition of mares. (*Gestation period, 340 days*)[a]

DATE OF BREEDING	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
1	6	6	3	6	5	6	5	6	6	5	6	5
2	7	7	4	7	6	7	6	7	7	6	7	6
3	8	8	5	8	7	8	7	8	8	7	8	7
4	9	9	6	9	8	9	8	9	9	8	9	8
5	10	10	7	10	9	10	9	10	10	9	10	9
6	11	11	8	11	10	11	10	11	11	10	11	10
7	12	12	9	12	11	12	11	12	12	11	12	11
8	13	13	10	13	12	13	12	13	13	12	13	12
9	14	14	11	14	13	14	13	14	14	13	14	13
10	15	15	12	15	14	15	14	15	15	14	15	14
11	16	16	13	16	15	16	15	16	16	15	16	15
12	17	17	14	17	16	17	16	17	17	16	17	16
13	18	18	15	18	17	18	17	18	18	17	18	17
14	19	19	16	19	18	19	18	19	19	18	19	18
15	20	20	17	20	19	20	19	20	20	19	20	19
16	21	21	18	21	20	21	20	21	21	20	21	20
17	22	22	19	22	21	22	21	22	22	21	22	21
18	23	23	20	23	22	23	22	23	23	22	23	22
19	24	24	21	24	23	24	23	24	24	23	24	23
20	25	25	22	25	24	25	24	25	25	24	25	24
21	26	26	23	26	25	26	25	26	26	25	26	25
22	27	27	24	27	26	27	26	27	27	26	27	26
23	28	28	25	28	27	28	27	28	28	27	28	27
24	29	29	26	29	28	29	28	29	29	28	29	28
25	30	30	27	30	29	30	29	30	30	29	30	29
26	31	31	28	31	30	31	30	31	31	30	31	30
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
27	1	1	1	1	1	1	1	1	1	1	1	1
28	2	2	2	2	2	2	2	2	2	2	2	2
29	3	3	3	3	3	3	3	3	3	3	3	3
30	4	—	4	4	4	4	4	4	4	4	4	4
31	5	—	5	—	5	—	5	5	—	5	—	5

[a] How to use: First, find the date of breeding in the first column. The date the mare is due to foal is then determined by looking for the date on the same line as the date of breeding in the same column in which the month of breeding on top line is found. For example, if the mare is bred on March 23, she may be expected to foal on February 25.

A PRELIMINARY STUDY OF THE EFFECT OF PRESSURE UPON THE NITROGEN CHANGES IN THE SOIL[1]

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The daily variation in atmospheric pressure may have some effect upon the nitrogen changes taking place in the soil, hence the importance of this study.

It is known that the resistance of the microorganisms to pressure is very great, although there are certain species the resistance of which is rather low. The maximum pressure for *B. prodigiosus*, for example, was found to be between 5.4 to 6.3 atmospheres (Marshall, 1921).

Higher pressure favors a greater condensation of the atmospheric gases which are utilized by the organisms in their activities; also, increased pressure has been found to accelerate certain bacterial growth. Purely chemical reaction in connection with nitrogen transformations in the soil are known to take place although in a negligible degree, and laboratory experiments show in most instances that pressure hastens chemical reactions. Having these effects of pressure in mind, it is reasonable to expect that an increase of pressure may increase the rate of the biological changes in the soil. However, the actual laboratory tests have not shown this to be the case. Winters (1924) in studying nitrification and nitrogen fixation used pressure varying from 25 to 37 pounds per square inch upon the soil cultures incubated from two to four weeks. He concluded that increased pressure did not increase the bacterial activities. Brown (1923) studied sulfofication and nitrification, using 20 pounds and 50 pounds pressure per square inch upon soil, washed quartz sand, and liquid cultures incubated for 50 days. The results showed that when compared with the atmospheric pressure, 20 pounds pressure increased sulfofication and nitrification very slightly while 50 pounds pressure depressed these processes. The following experiments were undertaken to throw more light upon the effect of pressure on the nitrogen changes in the soil.

EXPERIMENTAL WORK

Plan

Series of experiments were carried to determine the effect of pressure upon ammonification, nitrification, denitrification, and nitrogen fixation processes. For this purpose 15 pounds pressure per square inch (6.8 kgm. per 6.45 sq. cm.) was used and compared with atmospheric pressure.

Soils used

The soils used were obtained from the experimental field of Cornell University Agricultural Experiment Station. These are Soil 1, Dunkirk silty clay loam; Soil 2, Clyde clay loam; and Soil 3, Dunkirk gravelly fine sandy loam. These soils were secured from the field in June, 1923, to a depth of 8 inches (20 cm.)

[1] Experiment Station contribution No. 307.

and taken to the laboratory in sacks. They were rubbed through a 2 mm. sieve, and kept in stoppered five gallon (22.5 liters) bottles during the course of the experiments.

Analyses of the three soils for the most important constituents and properties having a direct bearing on this investigation were made immediately. The analyses follow:

TABLE 1

Analyses of the three soils

	NO. 1 DUNKIRK SILTY CLAY LOAM	NO. 2 CLYDE CLAY LOAM	NO. 3 DUNKIRK GRAVELLY FINE SANDY LOAM
Moisture when bottled	5.6%	15.8%	2.9%
Water-holding capacity	53.8%	83.7%	37.6%
Ammonia nitrogen (per 100 grams)	5.6 mgm.	20.6 mgm.	1.7 mgm.
Nitrate nitrogen	58.0 ppm.	10.5 ppm.	trace
Total nitrogen (per 100 grams)	152.46 mgm.	274.88 mgm.	81.60 mgm.
pH value, colorimetric	6.3	7.0	6.5

These analyses show that the three types of soils are quite different in physical, chemical, and probably biological properties.

In all further reference to these soils the numbers only will be used.

Preparation of soil cultures

The containers used in this work were crystallizing dishes having a diameter of 125 mm. and height of 65 mm. Two hundred grams of soil (on dry basis) were used in each culture. This amount made a layer of from 20 to 30 mm. thickness in the container. Thus a large portion of the soil culture was in contact with the surrounding atmosphere. The dishes were covered with loosely fitting cover glasses. The treatments of the different cultures will be described in connection with the separate series of experiments.

Incubation

The soil cultures were incubated in a pressure tank at a pressure of 15 pounds per square inch. The tank was described briefly by Brown (1923) as follows: "The tank is a cylindrical galvanized iron about 2½ feet in diameter and 4 feet in length. The openings consist of a bolting door at one end, and an inlet pipe fitted with a pressure gauge at the other." Each set of pressure experiments was parallel at the same time with an atmospheric pressure set. The latter was incubated in a closed chamber, 24 inches (61 cm.) long, 19 inches (48 cm.) wide, and 15 inches (38 cm.) high, at room temperature. The incubating chamber was placed close to the pressure tank. The moisture conditions in the chamber were made uniform by placing a bowl of water inside. The arrangement would simulate the moisture conditions in the pressure tank since the tank was also closed during the incubation period. The loss of water in both cases during the incubation period was very little. Thus the temperature and the moisture conditions in the tank and in the chamber were practically the same.

Preparation of samples for analysis

After the incubation period, the soils were spread separately in the laboratory and air-dried over night; and then dried in an air oven the following morning at a temperature of approximately 100° C. for 4 hours. These dried soils were then

ground in a mortar so that they would pass through a certain mesh, the size depending upon the kind of analysis to be made. After grinding, they were placed in 8-ounce (226-gram) dried bottles and tightly stoppered, and shaken for several minutes with a No. 0 rubber stopper inside the bottle to assure better mixing. They were then ready for analysis.

Method of analysis

Determination of ammonia. Ammonia was determined according to Richmond's (1918) extraction method. The method was slightly modified, but the principle remained the same. Duplicate samples of 50 grams each of dry soil, ground to 40 mesh, were placed in bottles of 500 cc. capacity. Two hundred cc. portions of dilute hydrochloric acid (1 : 10) were added, and extraction made by shaking the bottles continuously for 5 minutes. The contents were allowed to settle for 10 minutes; 100 cc. of the supernatant liquid from each bottle were transferred to separate Kjeldahl flasks, made alkaline with magnesium oxide, and the ammonia nitrogen distilled over into the standard sulfuric acid solution. The excess of sulfuric acid was titrated back with standard sodium hydroxide, using alizarine-sulfonate as indicator.

Determination of nitrates. The modified phenol-disulfonic-acid method (Noyes, 1919) was used. Duplicate samples, each weighing 40 grams, of dry soil, ground to 40 mesh, were placed in tumblers; 5 grams of finely ground calcium oxide and 200 cc. of distilled water were added. Each sample was stirred continuously for 5 minutes and allowed to settle for at least 15 minutes; the supernatant liquid was clarified with alum (potassium aluminum sulfate). The nitrate extracts were then passed through filters. Twenty-five cc. of the filtrate were placed in the porcelain dishes and evaporated to dryness on the water bath. When the dishes were cooled, 1 cc. of phenol-disulfonic-acid solution was slowly poured into each dish and allowed to spread over and soak up the residue, the dish being rotated to make sure that the acid was in contact with the nitrates. The dishes were allowed to stand for 15 minutes, and then treated with 15 cc. of cold distilled water. The solutions were made alkaline with dilute ammonium hydroxide (4 to 8 per cent) until the yellow color was permanent, and finally diluted to a convenient volume for the determination. The standard nitrate solution was treated in just the same way, and diluted so that the solution would contain ½ ppm. of nitrate nitrogen. The unknown nitrate solution was then compared with the standard in a Schreiner colorimeter.

Determination of total nitrogen. The Gunning-Hibbard method (1919) was used for the determination of total nitrogen. Duplicate samples of 5 grams each of dry soil, ground to 100 mesh, were digested in 500 cc. Kjeldahl flasks with 30 cc. of concentrated sulfuric acid, plus approximately 10 grams of salt mixture composed of 10 parts of potassium sulfate, 1 part of ferrous sulfate, and ½ part of copper sulfate. The digestion was continued until the mixture was nearly colorless. After cooling, the determination was completed in the usual way.

RESULTS AND DISCUSSION

Ammonification

Two samples, two hundred grams each, of the three soils, were weighed into crystallizing dishes and 1 per cent of casein added. The casein was mixed

thoroughly by stirring with a spatula which had been flamed. The moisture content was made up to 60 per cent of the water-holding capacities of the soils as recommended by Greaves and Carter (1920).

One of the treated samples of each soil was incubated in the pressure tank, and the other in the incubating chamber for 5 days. After incubation the soils were dried at about 100° C. to constant weight. Since it was possible that a portion of the ammonia in the soils might be in the form of ammonium carbonate, which being volatile at higher temperatures, would be lost on drying the soils, a preliminary experiment was conducted to check any possible loss of ammonia. It was found that no ammonia was lost from the soils on drying. Brown (1923) using an entirely different method to check the loss of ammonia also found a negative result.

The results are given in table 2. It will be observed that the amounts of ammonia nitrogen found in the three soils used were practically the same where atmospheric pressure and where 15 pounds pressure per square inch were used. It appears then that a pressure of 15 pounds has no effect upon ammonification.

TABLE 2

Effect of pressure upon ammonification

Soil	Mgm. ammonia nitrogen accumulated per 100 grams of soil			
	Atmospheric pressure		15 pounds pressure	
	Found	Average	Found	Average
1	66.57 66.57	66.57	66.57 66.14	66.36
2	64.00 64.43	64.22	64.00 64.00	64.00
3	48.96 48.10	48.53	49.82 48.96	49.39

Nitrification

In this study the term nitrification is used in a broad sense to imply the accumulation of nitrate nitrogen from the decomposition of organic matter. For this purpose the nitrates accumulated during the incubation period were measured.

Two samples, two hundred grams each, of the three soils were weighed into the crystallizing dishes previously described. The moisture was made up to 60 per cent of the water-holding capacities of the soils (Greaves and Carter, 1920). No nitrogenous material was added for nitrification. A sample of each soil was incubated in the pressure tank and the other in the incubating chamber. The incubation period was three weeks. Since there was very little loss of water during the incubation period, that loss of water was not replaced.

The results are given in table 3. It will be noted that in all cases a pressure of 15 pounds per square inch caused a slight depression of nitrate accumulation. This depression, however, could not be regarded as significant, since the duplicate determinations in the case of Soil 1 gave a difference of 5 ppm., and in the case of Soil 2, 3 ppm. It seems that pressure does not accelerate nitrification, but slightly depresses the process. Brown (1923), on the other hand, found increased nitrification with 20 pounds pressure per square inch and a depression with 50 pounds; while Winters (1924) found no consistent positive results with pressure varying from 23 to 37 pounds per square inch.

TABLE 3

Effect of pressure upon nitrification

SOIL	NITRATE NITROGEN ACCUMULATED			
	Atmospheric pressure		15 pounds pressure	
	Found	Average	Found	Average
	ppm.	*ppm.*	*ppm.*	*ppm.*
1	100.0 105.0	102.5	90.0 90.0	90.0
2	53.3 56.6	55.0	53.3 50.0	51.7
3	28.3 28.3	28.3	26.6 26.6	26.6

Denitrification

This study deals only with one phase of the nitrification process; namely, the loss of nitrates by deoxidation or reduction whether partial or complete; consequently, denitrification as used in this paper indicates only such losses of nitrates. For this purpose, determinations were made of the nitrate left unreduced.

Two portions, two hundred grams each, of each of the three soils, were placed in crystallizing dishes. To these were added 2.5 per cent of dextrose, which was mixed thoroughly with the soil by stirring, for three minutes, with a spatula which had been flamed. Twenty cc. of potassium nitrate solution containing 120 mgm. of nitrogen (60 mgm. for each 100 grams of soil) were added, and the soil again stirred for another three minutes to insure a uniform distribution of nitrates in the cultures. Finally the moisture content was made up to 70 per cent of the water-holding capacities of the soils. With this amount of moisture the soils appeared sufficiently wet to exclude the air, thus forcing the bacteria to make use of the oxygen present in the added nitrate and dextrose. A culture of each soil was incubated for one week in the pressure tank and the other in the incubating chamber. In the study of the effect of temperature on the nitrogen changes in the soil this incubation was found by the writer (1925) to be long enough.

The results are given in table 4. It will be observed that whether atmospheric pressure or 15 pounds pressure was used, the residual, or unreduced nitrate nitrogen left in the three soils was practically the same. Pressure, again, has no effect upon this process.

TABLE 4

Effect of pressure upon denitrification

SOIL	NITRATE NITROGEN LEFT UNREDUCED			
	Atmospheric pressure		15 pounds pressure	
	Found	Average	Found	Average
	ppm.	*ppm.*	*ppm.*	*ppm.*
1	260.0 270.0	265.0	250.0 260.0	255.0
2	220.0 220.0	220.0	220.0 230.0	225.0
3	170.0 170.0	170.0	170.0 170.0	170.0

Nitrogen fixation

In conducting this part of the investigation, nitrogen fixation was determined under both ærobic and anærobic conditions. "Anærobic conditions" in this work should mean an approximate anærobic environment in which the organisms were forced to live as facultative anærobes. For this purpose, four samples, two hundred grams each, of the three soils, were used. Two samples were for the ærobic condition and the other two were for the anærobic. These samples were placed in the crystallizing dishes and two per cent mannit added in each case. The mannit was mixed thoroughly with the soil by stirring with a spatula which had been flamed. Following Greaves and Carter's (1920) technique for the most favorable moisture condition for nitrogen fixation under an ærobic atmosphere, the moisture was made up to 60 per cent of the water-holding capacities of the soils. For the anærobic condition the moisture was made up to 120 per cent of the water-holding capacities of the soils. With this amount of moisture the soils were under water, which assured an anærobic environment. The soil cultures were incubated in the pressure tank and in the incubating chamber. The water lost during the incubation period was very little; it was not replaced.

The total nitrogen was determined as outlined above in the method of analysis. If the duplicates failed to check within 0.2 cc. of 1.0738 NaOH in the titration, the determination was repeated. Under this limitation the extreme analytical error was approximately 4 mgm. of nitrogen per 100 grams of soil or 100 pounds of nitrogen per acre-foot of soil weighing 2,500,000 pounds.

The results are given in table 5. It will be observed that under both ærobic and anærobic conditions the amounts of nitrogen fixed, where atmospheric pressure and 15 pounds pressure per square inch were used, did not show marked differences. The differences observed can not be considered significant if we

consider that the analytical error was about 4 mgm. per 100 grams of soil; differences which are approximately those observed in extreme cases. Winters (1924) also found a negative effect of pressure upon this process.

TABLE 5

Effect of pressure upon nitrogen fixation

SOIL	MGM. NITROGEN FIXED PER 100 GRAMS OF SOIL					
	Atmospheric pressure			15 pounds pressure		
	Found	Average	Fixed	Found	Average	Fixed
			Aerobic conditions			
1	154.62 156.76	155.19	2.73	152.46 152.46	152.46	0.00
2	283.48 283.48	283.48	8.60	281.32 277.04	279.18	4.30
3	85.90 85.90	85.90	4.30	85.90 85.90	85.90	4.30
			Anærobic conditions			
1	154.62 154.62	154.62	2.16	152.46 156.76	154.61	2.15
2	274.88 277.04	275.98	1.10	272.74 274.88	273.81	—1.07
3	90.18 90.18	90.18	8.58	85.90 85.90	85.90	4.30

GENERAL CONSIDERATION OF RESULTS

A pressure of 15 pounds per square inch does not seem to have any effect upon the nitrogen changes taking place in the soil, such as ammonification, nitrification, denitrification, and nitrogen fixation under both ærobic and anærobic conditions. Brown (1923) reported that a pressure of 20 pounds per square inch accelerated nitrification slightly, while 50 pounds depressed the process. On the other hand, Winters (1924) found that in comparison with atmospheric pressure, pressure varying from 23 to 37 pounds per square inch did not produce a consistent positive result on nitrate accumulation. The test on nitrogen fixation showed that a pressure as high as 30 pounds per square inch did not affect the process. On the whole, it seems that the daily variation of atmospheric pressure, which does not vary more than a small fraction of 15 pounds per square inch, has no measurable effect upon the bacterial activities in the soil.

SUMMARY

The effect of a pressure of 15 pounds per square inch upon nitrogen changes in the soil, such as ammonification, nitrification, denitrification, and nitrogen fixation has been studied.

This pressure did not produce a measurable effect upon ammonification, nitrification, denitrification, and nitrogen fixation in the soil, indicating that the daily changes of atmospheric pressure have no effect upon these processes.

ACKNOWLEDGMENT

The writer expresses sincere thanks to Dr. J. K. Wilson of Cornell University under whom this work was undertaken.

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VITAMIN B IN TIKITIKI EXTRACT PREPARED BY THE PHILIPPINE BUREAU OF SCIENCE[1]

F. O. SANTOS AND E. G. COLLADO

Of the Department of Agricultural Chemistry

WITH ONE CHART

Since 1914 tikitiki extract has been considered the best medicine known for the treatment of infantile beriberi (Albert, 1925). In the Philippines this extract is used not only for infantile beriberi, but also in many cases of malnutrition among adults.

Extract of rice polishings (tikitiki) is generally considered a good source of vitamin B; but it has not been demonstrated yet that tikitiki extract as prepared by the Bureau of Science of the Philippine Islands contains an appreciable amount of this vitamin. The extract is rich in anti-neuritic vitamin (Wells, 1921). But vitamin B and the anti-neuritic vitamin are not identical (Levene and Muhlfeld, 1923).

Owing to the non-identity of these two vitamins and the increasing popularity of the tikitiki preparation, it is deemed advisable to report the following experiments.

This work was performed primarily for the purpose of finding a substitute for the expensive Harris Yeast Extract in the feeding work we are carrying on in this laboratory.

MATERIALS

The tikitiki extract used in this investigation was furnished by Mr. Ramon Feliciano of the Bureau of Science. The essential steps in the preparation of the extract follows (Wells, 1921):

> The tikitiki (rice polishings) is treated with twice its weight of 25% alcohol and extracted with some agitation for 48 hours, and then decanted. The residual sludge is pressed and the pressed liquid is combined with the original extract. These combined extracts are then distilled at a pressure of 1 centimeter with a maximum temperature of 75°C. Distillation is continued until the gravity of the extract has reached 1.18 at 70°C. The syrup is then allowed to stand over-night to settle completely, then decanted, and the cloudy portion is passed through a Sharples supercentrifuge.
>
> To further free it from inactive substances, the resulting clarified syrup is treated with slightly over ⅓ of its volume of 95% alcohol, the gummy precipitate formed is separated by means of the supercentrifuge. The alcoholic solution is then distilled and the syrup concentrated as before. The density of this syrup is brought to 1.32 and then cooled. The flocculent precipitate of inactive substances which form during cooling is separated by centrifugation. The final product is then boiled to 65°C., bottled, and pasteurized for three successive days at 62.5°C.

[1] Experiment Station contribution No. 308. Received for publication July 9, 1925.

Six healthy white rats kept in separate cages were used as the experimental animals.

The ration deficient in vitamin B had the following composition:

Corn starch	64	per cent
Casein	18	"
Butter fat	9	"
Salt mixture	4	"
Lard	3	"
Filter paper	2	"

The corn starch (Chief brand) was obtained from the local market. The casein was imported from Merck & Co.; it was washed five times with water and then ground. The filter paper was well macerated, pressed and then dried. The salt mixture prepared according to McCollum and Davis (1915) had the following ingredients:

Sodium chloride	5	grams
Di-potassium acid phosphate	12.1	"
Primary calcium phosphate, monohydrate	2.56	"
Calcium lactate	29.44	"
Iron citrate	1.0	"

METHOD

The feeding technique used was essentially the same as reported by Ferry (1920). The animals were first given the vitamin B deficient diet and allowed to decline in weight. Then tikitiki was given daily as supplement to the ration. Records of body weight and food intake were taken weekly. Water was given ad libitum.

RESULTS

The records of body weights and basal food intake are given in table 1. The body weights are also recorded in chart I. It is evident that the rats which declined in weight owing to lack of vitamin B, recovered on a daily supplement to the deficient ration of ½ cc. tikitiki extract. The vitamin B potency of tikitiki extract is thus established.

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TABLE 1

Showing weekly body weight of white rats and their basal food intake

DATE	½ CC. SUPPLEMENT						1 CC. SUPPLEMENT					
	3♂		4♂		5♀		6♂		7♂		8♀	
	Body wt.	Feed	Body wt.	Feed	Body wt.	Feed	Body wt.	Feed	Body wt.	Feed	Body wt.	Feed
	gram	*gram*	*gram*	*gram*	*gram*	*gram*	*gram*	*gram*	*gram*	*gram*	*gram*	*gram*
September 8, 1923	53		114		50		53		58		61	
15	51	23	118	57	38	18	50	19	58	22	60	34
22	53	25	127	55	38	17	43	14	50	12	58	27
29	53	24	126	59	38	20	39	14	43	19	65	28
October 6, 1923	50	16	119	30	38	19	38	18	46	21	60	26
13	50	15	107	35	39	18	39	22	44	23	65	60
20[a]	51	23	93	29	38	30	38	23	44	29	60	20
27	70	25	90	35	50	67	61	50	67	66	83	65
November 3, 1923	72	40	115	75	50	33	75	60	65	44	100	57
10	83	40	130	64	55	28	92	50	70	47	105	42
17	90	33	138	74	58	27	100	50	75	40	106	46
24	90	37	140	65	65	38	103	49	75	35	112	55
December 1, 1923	90	30	145	60	70	32	104	36	81	48	120	65
8	92	35	155	80	74	35	104	35	98	52	133	65
15	95	40	160	70	75	30	108	35	115	70	137	75
22	92	40	157	80	81	63	115	65	135	80	135	45
29	98	35	162	65	96	37	123	53	142	62	142	53
January 5, 1924	100	45	173	80	100	53	130	57	155	65	150	62
12	107	45	180	79	111	62	134	70	165	73	155	42

[a] Beginning of daily supplement.

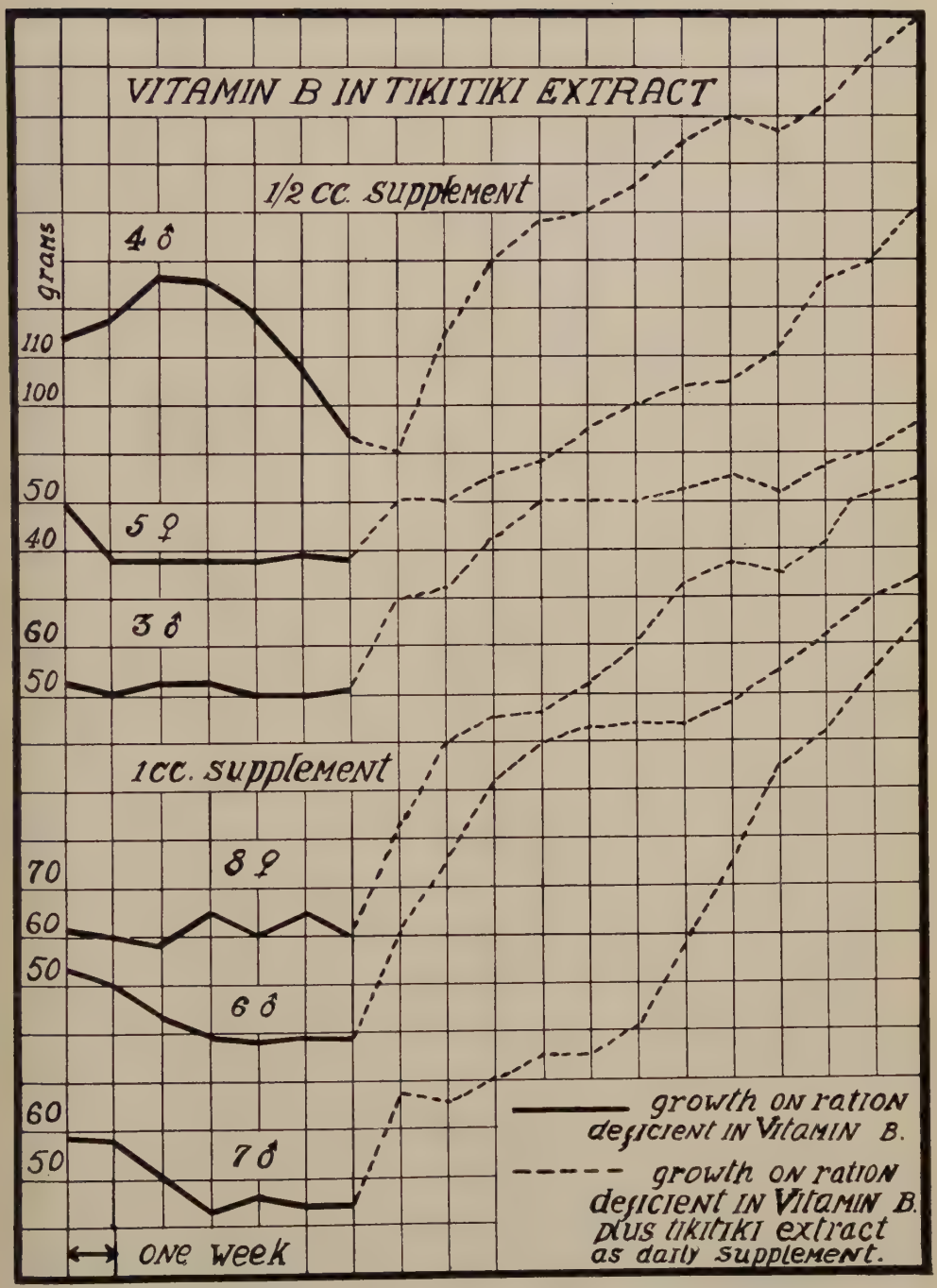
VITAMIN B IN TIKITIKI EXTRACT
1/2 cc. supplement
grams
4 ♂
110
100
50
40
5 ♀
60
50
3 ♂
1cc. supplement
70
60
50
8 ♀
6 ♂
60
50
7 ♂
ONE Week
growth on ration deficient in Vitamin B.
growth on ration deficient in Vitamin B. plus tikitiki extract as daily supplement.

CHART I

NOTE: RECENT TRIP TO DARWIN, AUSTRALIA[1]

With two members of the faculty of the College of Veterinary Science and a member of the Forest School faculty as traveling companions, the writer made a month's trip (Dec. 22 '24—Jan. 24 '25) to the cattle shipping port, Darwin, Australia. We traveled on a cattle boat through the courtesy of Messrs. Soriano and Buencamino, Manila cattle importers.

On the outgoing trip we called at Sibetik, British North Borneo, to coal; put in for repairs at Soerabaya, Java, this last not being in our itinerary when we left Manila.

In both of these places we found much that was of interest; but in this brief "note" I shall confine myself to live stock, the real object of the trip.

Java

In the island of Madoera, near Soerabaya, the soil, judging from its appearance and the growing crops, is very poor. Most of the cattle seen were raised in small numbers by peasants. A few herds with cattle numbering around fifty in each were observed. There were also small herds of carabaos. Cattle were used almost exclusively for farm work, and many of these were cows with suckling calves. The Madoera cattle are small, about the same size as ours from Fuga Island. Those from Bali are larger and may compare with the better kind of Philippine cattle. The predominant color is yellow, like our own cattle.

Indian blood was apparent in most of the stock used for carting.

As the Javanese are mostly Mohammedans, hogs were not much in evidence. The meat consumed in Java is mostly beef. The people live on fish to a large extent. The fishing boats abound on the coast and we encountered many of them far out on the sea.

The horses as seen in the streets of Soerabaya are about the size of those found in the streets of Manila. In appearance they are not as refined as the Philippine horses, but show a much better development of the hind quarters, a part usually defective in the Philippine horse.

The goats are of varied colors and of an unimproved stock, not unlike our common goat.

Australia

Through the courtesy of the Northern Agency, from which Mr. Soriano buys cattle for the Philippine trade, we were taken around the meat works at Darwin. This is a big establishment built up during war times at a cost of about one million pounds to supply beef to the British army. It functioned for about four years and closed down after filling the government contracts for which it was established. The plant has a capacity of approximately 400 head of cattle daily and

[1] General contribution from the College of Agriculture No. 146.

is provided with all the facilities found in up-to-date packing houses, including canning machinery, sausage machines, a fertilizer plant, etc. At the time we were there they were considering re-opening the works at a reduced capacity. This is claimed to be the largest packing house in the southern hemisphere.

We missed by a few hours the cattle train going into the interior to bring the animals for our boat, and therefore gained our knowledge of Australian live stock conditions mostly second hand from men who have been in the work. Australia is so big that one can hardly conceive of the time needed to go over just a portion of it. With a day and a half at our disposal we could not do very much. Through the courtesy of Mr. Holmes, a former resident of Zamboanga, we were driven into an outlying paddock where his cattle to be shipped on the next steamer were being held.

The ranches are called stations and vary in size from about 700 square miles, or about the size of Laguna province, to 13,000 square miles, or the combined size of the central Luzon provinces of Pangasinan, Nueva Ecija, Tarlac, Zambales, Pampanga, Bulacan, Bataan, Rizal, Cavite, Laguna, and Batangas. This latter is the Victoria River Downs Station, owned by the Bovril people. The estimated carrying capacity of the ranges in the Northern Territory is from one to two head per square mile (259 hectares).

Medium sized stations are usually managed by about ten Australians and from 40 to 80 aborigines. The wages is about 6 pounds (₱58.40) a week for the former, and 2 shillings (₱0.97) for the latter, free board in each case. In addition, the station pays to the aborigines department of the government two shillings for each native employed. This money is administered for work among the natives.

The stock is mostly of Shorthorn origin, although, lately, Hereford is being introduced rather extensively, as the cattlemen believe such a cross produces a hardier and a more uniformly fleshed animal.

With such large ranges and a dry country it becomes necessary many times to bore wells from which the stock may be watered. As many as four thousand cattle congregate in such centers and motor pumps have to be kept going for twenty hours a day in dry weather to allow eight gallons of water to an animal. Where windmills can be used, they are utilized. Natural watering places consist of rivers and shallow lakes called "billabongs". Most of these dry up in the long dry season.

A distance of 30 miles from one watering place to another is considered satisfactory. The claim is made that cattle can smell water six miles away.

No effort is made to improve the ranges. They are so large and labor is so scarce and high priced as to make this impractical. When the grass grows rank, as it does in some places to as long as ten to fifteen feet, it is burned down. The young grass shoots up then, but with it considerable brush. Thoughtful stockmen recognize this gradual diminution of their grazing areas, but are little concerned as land is plentiful.

When the drought becomes severe, the animals begin to die. The stockmen reckon on a death rate of about 10 per cent yearly in their stock, and of this 7 per cent is directly attributable to drought. When animals die, birds of prey dispose of their carcass. Not even the hide is saved, as the cost to transport it to market is prohibitive.

The stock travels to market at the rate of about 60 miles a week. There are regular cattle paths to the railroad terminus at Katherine, about 200 miles from Darwin.

The prevailing price at Darwin for cattle at the time of our visit was 5 pounds (₱48.67) per head, weight about 1000 lbs. (453.6 kilograms). The retail price of meat was 4 pence a pound or about 16 centavos.

In the lowlands of Marrokai in the coastal region of the Northern Territory, and in Melville Island, just off the coast of Darwin, wild carabaos are found. These are supposed to have been introduced from Java by the Dutch in the early colonization of Australia. They are now hunted regularly for their hides, which bring about a pound (₱9.73) a piece.

As may be surmised, the Australian seasons are opposite to ours. There the warm months are December, January, and February. The cattle are at their worst before the rainy season, which is from January to March. From June to August the cattle are at their best. This is the period of activity in the stations, when cattle are branded, castrated, and culled. Because of the relative abundance of cattle at this period, prices are usually at the lowest.

The land laws prevalent in the Northern Territory are interesting. Most of the cattle stations are owned by English capitalists. The land is leased to them for from 44 to 99 years at an annual rental of from 1 to 6 shillings (₱0.48 to ₱2.92) per square mile according to the quality of the land, with an average of 4 shillings. The idea behind this is that the government gets a steady revenue, and at any time the country may require the land for its growing population, it may take it back and partition it off. The greater portion of the land is leased for pastoral purposes absolutely, and outside of home gardens no cultivation is allowed.

The cattle coming in from the trains are unloaded into a yard and driven through races, or chutes along the pier directly on the boat. The boat is partitioned off into small enclosures holding from ten to fifteen animals approximately. Convenient runways lead into the the three decks of the ship. With these facilities loading or unloading takes only from three to four hours. Each enclosure is provided with a trough used alternately for feed and water. Canvas ventilators leading into the hold of the ship are installed to provide fresh air for the stock.

The animals on our ship were restless for a day or two, then settled down and began to eat. The feed given them was mixed alfalfa hay imported from America. Animals unable to stand confinement lost weight steadily, but the majority ate well and apparently gained weight. Of the 529 animals on our boat one jumped back on to the pier and was lost, one died from goring, and another was so weak that it died soon after arrival. Three others were very weak, but some way managed to travel to the stockyards at Sisiman. Twenty Filipino cattlemen were employed to tend the cattle on the trip.

The trip from Darwin to Sisiman takes eight days, and during that time urine and manure accumulated on deck. The ammonia generated was at times almost soporific.

B. M. Gonzalez,
Professor of Animal Husbandry.

EXCHANGE NOTES

It is the purpose of the editors of the *Lingnaam Agricultural Review* to limit the scope of their publication to China. We cannot refrain, however, from pointing to the work of an institution in the Philippines with which we have had a most helpful relationship. We are fully convinced that agricultural institutions in China have much to learn from the experience of the College of Agriculture, University of the Philippines. Dean C. F. Baker, of this college, has recently sent us a fine photograph of their project at Los Baños, showing in a striking manner the twelve year development of this institution from the jungle. This college is one of the greatest and most successful experiments in agricultural education of recent years. At Los Baños there is in the building one of the most solid and permanent foundations for tropical agriculture which has yet been established. It is not only a well known educational center, but in spite of insufficient appropriations for research and experiments it has become a classical station in mycology and entomology, the type locality of several thousand species.

—*The Lingnaam Agricultural Review*, (Canton Christian College, China.)

The Song of the Lazy Farmer

My neighbor's got his plowing done and clods all busted, ev'ry one, he's harrowed that cornfield of his until it's fine and smooth; gee whiz, the work he's put on that there field had ought to make a bumper yield. I never saw a man like him who toils away with such a vim, he'll work until the moon comes out to put the weeds and grass to rout, he wants that corn to have a chance to put some money in his pants. He works all day without a stop to make more money from his crop; most ev'ry time I see him pass by my old cornfield, full of grass, he shakes his head; I guess, by heck, he'd like to get me by the neck and make me root that quack grass out and give my corn a chance to sprout.

I like to see a field that's clean, but when the trees are getting green I like to sit and rest a bit, I ain't no hand to have a fit if my work ain't right up to date, what if it is a little late? Some people just rush all through life and fill their days with toil and strife and all they've got, when life is done, is just a lot of land and mon for relatives to quarrel about before the corpse has been laid out. I'd rather fill my days with joy by sittin' in the shade, Oh boy! I won't leave much cash when I'm dead, but I'm a lot of fun ahead!

—*The Prairie Farmer.*

The United States boasts not less than a dozen goldfish farms situated in nine states. A conservative estimate of the output of these farms is 17,000,000 gold fishes per annum. An equally conservative estimate of those hatched only to be martyred, is 99-16/17 per cent.—I. M. M.

—*Zoological Society Bulletin.*

A great deal is being said about legislatures passing too many laws. Doubtless some of this criticism is true. If we expect lawyers to simplify laws and reduce the number of them, however, we shall probably be disappointed. The more laws we have, and the more complicated they are, the more lawyers we need to keep us out of jail.

—*The Prairie Farmer.*

The yolk of egg is very useful for anaemic people, while in infant nutrition the soft-cooked yolk is introduced into the child's diet at the end of the ninth month. Milk contains very little iron, but nature has so planned it that the child comes into the world with a supply of iron stored in the body. At the end of the first nine months, however, this supply is exhausted or nearly so, and this mineral must be supplied from other sources or the child is bound to suffer.

No other food, except milk, has so abundant a supply of calcium as egg yolk. It seems as if these calcium salts are also present in organic combination, and are therefore very easily used. In regard to vitamins, the yolk has proved a useful source of one of these food essentials. The fat in the yolk contains the soluble A, which prevents the eye disease known as Xerophthalmia.

Nine eggs have about the same nutritive value as one pound of beef. They may therefore readily be used as a substitute for meat.

Eggs therefore have the same total nutritive material as meat, but are richer in fat and poorer in protein.

During the digestion of meats, purins are yielded which are responsible for gout. This food is therefore eliminated from the diet when this disease is being treated. In the egg there is no such substance present, so that it can be used freely in such a diet.

One egg = 1/2 glass milk = 1-½ oz. medium fat meat. There is no difference in the nutritive value between white-shelled and brown-shelled eggs. Also, duck and goose eggs have about the same composition. They are, however, larger—a duck's egg weighing about 2-1/2 oz. and that of a goose from 5-1/2 to 6-1/2 oz.

Journal of the Department of Agriculture. (Union of South Africa.)

COLLEGE AND ALUMNI NOTES

Among College visitors in July were Mr. Norman Littell and Mr. Arthur Patterson, students of maritime law in Harvard University, making a trip around the world as part of the crew on the U. S. freighter *Archer*. Mr. Littell is a former Rhodes scholarship man from Wabash College, Indiana. He studied three years in Oxford. Both men expressed much interest in the work of the College of Agriculture, commenting especially on the democratic spirit found here and the opportunities held out to the poor students. Mr. Littell stated that most of English colleges lack this spirit and that higher education there is only within the reach of the upper classes. While in port, these sailor travelers "did" the historic attractions of Manila and environs and judging by their comments found much of interest.

Assistant Professor Archie B. Nourse joined the staff of the English Department this year. Mr. Nourse hails from Iowa. Was graduated from Grinnell College with degree of A. B. and received from Iowa University, Master's degree in English Literature and Composition *in absentia* after he sailed for the Philippines in May. Mr. Nourse hopes to find material for short stories in the Islands, a line of writing in which he has not only interest but experience.

Mr. Pablo N. Mabbun, B. S. '23, who resigned in July, 1924, as assistant in Rural Economics Department to accept a position in the High School of Cagayan Province as instructor in biology, has been appointed as instructor in rural economics. Mr. Mabbun received a hearty welcome on his return from his former colleagues and other friends.

Mr. Eligio J. Tavanlar, B. Agr. '25, sailed recently for the United States. He will enter the Military Academy at West Point. Out of twenty who took the examination for appointment as cadet in the Academy, Mr. Tavanlar was one of the two who passed.

Dr. José S. Villacorta, formerly physician of the College of Agriculture, and now a private practitioner in San Pablo, Laguna Province, has opened a free consulting clinic in the drug store of Mr. Arcadio Ama in Los Baños on Thursday and Sunday mornings from 7:00 to 12:00 o'clock. Members of the faculty of the Colleges at Los Baños, and students are welcome at this clinic.

The committee on the Fourth of July celebration, composed of the Social Committees of the Faculty and of the Student Body, reports as follows on the success of the observance of the day:

1. A parade in the morning in which the faculties and the student bodies of the associated colleges and school of Los Baños participated. The parade was imposing. The Marshals on their beautiful mounts, the band, the cadets marching like seasoned soldiers, the Deans of the Colleges of Agriculture and Veterinary Science heading the faculties and student bodies, forgetting their decorum, but nevertheless lending dignity to the occasion, the respectable and dignified professors marching, perspiring, panting, trying to keep pace with the students and younger colleagues—all gave life to the affair. It suggested real democracy and true patriotism.

2. After the parade was reviewed, the College Librarian, Mr. Basilio Hernandez, read the Declaration of Independence, and Dean Baker delivered an inspired and inspiring address.

3. Guard Mount. The cadets performed splendidly. Every one was thrilled. Our cadets are to be highly commended.

4. The first part of an athletic program was held immediately after the cadets' review. It consisted of the following events: pillow fight, apple-eating contest, carabao race, tug of war.

5. In the afternoon, the second part of the athletic program was held, consisting of the following events: indoor baseball, basket ball, volley ball, bicycle race, walking race, and *palo cebo*. Rain prevented the other events being pulled off.

6. The day ended with a big bonfire on the Campus which kindled the spirits and renewed enthusiasm.

MARIANO C. LOPEZ, *Chairman*, Faculty Social Committee.
H. ROSALES, *Chairman*, Student Body Social Committee.

New books and other publications added to the Library of the College of Agriculture, June 1-30, 1925.

Arellano y Remedio, Manuel
Discurso leído en la solemne apertura del curso académico de 1923 a 1924 en la real y pontificia universidad de Santo Tomás de Manila.

Bacon, John Lord.
Forge-practice and heat treatment of steel. 1919.

Buck, John M.
The differentiation of primary isolations of bacterium melitinsis from primary isolations of bacterium abortus (bovine) by their cultural and atmospheric requirements.

Daugherty, R. L.
Centrifugal pumps. 1915.

Davidson, J. Brownlee.
Agricultural engineering. 1920.

Dyke, A. L.
Dyke's automobile and gasoline engine encyclopedia. 1924.

Estado da India. Governo geral do estado da India: O coqueiro.

Hawthorne, H. W.
Successful farming on eighty-acre farms in central Indiana.

Honson, Karl B., and H. L. Van Volkenberg.
Anthelmintic efficiency of carbon tetrachloride in the treatment of foxes.

Lyon, T. L., and H. O. Buckman.
The nature and properties of soils. 1922.

Manila. Philippine Sugar Association.
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